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THE SURGICAL TREATMENT OF TOPHACEOUS GOUT*

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GOUT is a chronic metabolic disorder associated with an increased concentration of uric acid in the blood. Early in its course it is characterized with few clinical manifestations except acute attacks of arthritis. As the disease progresses osseous and subcutaneous urate deposits appear and lead to physical deformity and persistence of low-grade symptoms. Patients with advanced changes may be seriously handicapped and suffer needlessly, due to the gradual increase in the size of the deposits. Since medicinal measures have been ineffective in treating these disabling tophi[9] recourse has been made to surgical treatment, with the expectation that considerable benefit would be obtained. The progressive course of the disease in no way has been affected but a lasting local benefit has been achieved that could not be produced by any other measures.

The surgical treatment of tophaceous gout in 11 patients constitutes the basis of this report. The operations were carried out at the Massachusetts General Hospital by the senior author (R. R. L.), or directly under his supervision. This was possible because of the medical study in a large group of gouty patients by the junior author (J. H. T.). In the group of patients treated surgically, there were ten males and one female. The ages ranged from 20 to 80 years. There were two in the third decade of life, one in the fifth, three in the sixth, two in the seventh, two in the eighth, and one in the ninth. Eight, or 73 per cent, were over 50 years of age. Seven patients had had gout for 20 years or more, two for 10 to 20 years, and two for seven years.

Historical Review.—Gout is a disease of great antiquity. Undoubtedly it is as ancient as civilization. Quoting from Garrod[1] (1858): "Gout . . . was probably one of the earliest diseases to which flesh became heir when man began to participate in the luxuries of civilized life: it is a disease, also, which can lay claim to having had among its victims some of the most renowned of the human race from their position, opulence, and intellect." The aphorisms of Hippocrates,[2] who lived about 350 BC., indicate that he was well acquainted with the manifestations of gout. Writers on the

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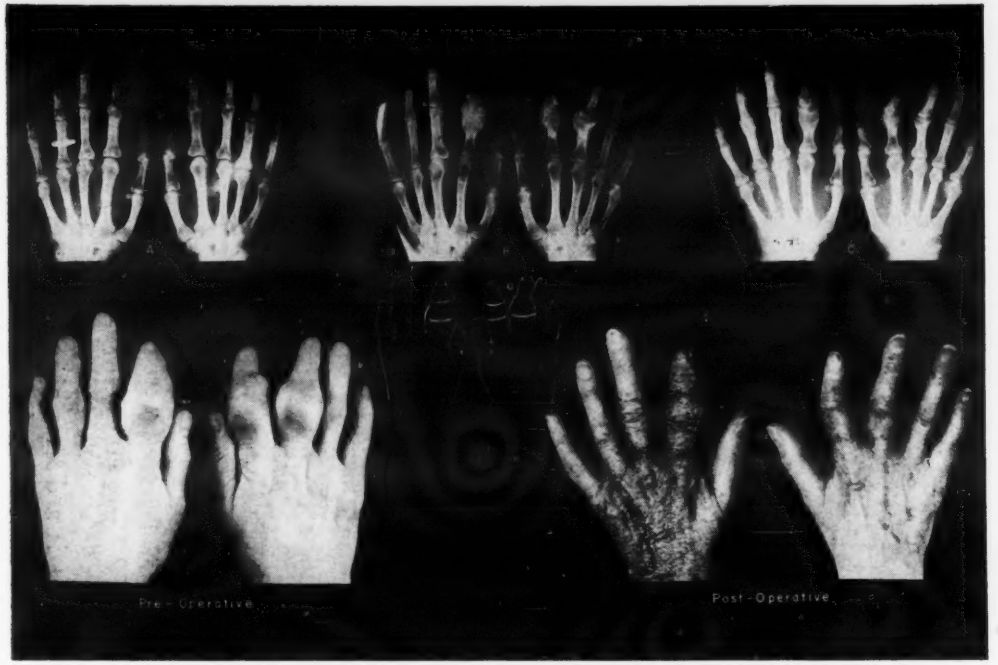


FIG. 1.—Extensive tophaceous deposits of the right and left index fingers and the middle right finger, which involved the phalanges and the extensor and flexor tendons. The patient, a female, age 49, had symptoms of gout for 32 years (The same patient as in Fig. 15). This case illustrates the rapidity with which tophaceous deposits may develop: (A) Roentgenograms, taken in 1933, show only slight evidence of osseous tophi. (B) Roentgenograms, taken in 1938, before the operations five years later, show extensive bone and joint destruction. (C) Postoperative roentgenograms showing some regeneration of the phalanges. The periosteum was preserved as far as possible, which accounts for this new bone formation. The operations were performed under novocain block anesthesia at the base of the fingers. The postoperative photograph and roentgenogram were taken about six weeks after the operations. Some shortening of the fingers is to be noted and the cosmetic result was not as good as in some of the other cases, although this improved after months, but in view of the extensive involvement of the bones, extensor and flexor tendons, the result was satisfactory, especially since the patient received relief from pain, could again wear gloves, and did not have to hide her hands when in public. Note the transverse incisions which were made, and the excellent healing of them.

subject have been very prolific since that time. Most dissertations, however, have been clinical descriptions, and neither the etiology of the malady nor the pathogenesis of symptoms have been discovered as yet. The most important contribution regarding the treatment of acute gouty arthritis was described first by Alexander, of Tralles, quoting Garrod,[1] in the sixth century. On empiric grounds he recommended the use of hemodactyl, the plant from which colchicum is derived. Among the many interesting volumes on the treatment of gout is one written by Missaurus,[6] in 1735: "Demonstrating that the Gout is one of the greatest blessings which can befall Mortal Man: That all Gentlemen who weary of it, are their own Enemies; and that those Practitioners who offer it the cure, are the vainest and most mischievous Cheats in Nature."

In contradistinction to the voluminous writings on the medical aspects, little has been written on the surgical treatment. In 1641, Paré[7] opened painful areas about tophaceous joints with the cautery and rubbed them with hemodactyl, gentian, mercury, or alum. Hippocrates[2] resorted to actual burning of the painful areas. He says in his "Treatise of Diseases," speaking of gout: "The Disease is indeed long and grievous, but not mortal; but if the Pain remains in the toes, burn them above the joints with Crude Flax." This method, according to Hutchinson,[3] was revived in the seventeenth century by Hermon Busschof, a Minister at Batavia, in the services of the Dutch East India Company. The method described by Busschof consisted in placing a small piece of Indian moss over the painful tophus and then setting fire to it. This treatment apparently afforded relief, since Busschof, a victim of the malady, admitted extraordinary alleviation of pain. Another patient, Sir William Temple, reported: "That when the Pain in his Great Toe was very violent, and he, in five Days, had not been able to stir his foot, but as it was lifted, he was suddenly relieved by the Moxa (burning of it), and walked half a dozen turns about the Room without pain or Trouble to the Surprise of those that were about him, as well as his own."

Hutchinson,[3] in 1880, was the first to report the surgical removal of two toes on account of suppuration of tophaceous deposits. Riedel,[8] in 1904, stated that the removal of urate deposits could be accomplished if the gouty arthritis were localized to the metatarsophalangeal joint of the great toe. He performed two operations, one on a man, age 45, and the other on a woman, age 70. A preoperative diagnosis of suppurative arthritis was made in each instance, and not until he discovered urate crystals in the bursae and the synovial membranes at the time of operation did he appreciate that the patients were suffering from an acute attack of gout. In each case he simply opened the joint space and removed as much of the urate crystals as possible, then left the wound open to heal by secondary intention. The incisions healed in a few weeks, following which one patient was free of attacks for 14 years and the other for eight years, or until her death.

Lindsay,[4] in 1913, found that healing occurred naturally, provided the incision was made over the more healthy skin towards the base of the

FIG. 2.—Tophaceous deposits involving the index and fourth fingers of the right hand. The patient, a male, age 69, had symptoms of gout for 15 years (The same patient as in Fig. 9). The roentgenogram shows moderate involvement of the bones. Only the tophus on the fourth finger was removed, at the patient's request, but since he obtained such a satisfactory result on this one he is planning to have the one on the index finger removed. The operation was performed under novocain block anesthesia at the base of the finger. The tophus was removed through a transverse incision. It involved the extensor tendon but it was possible to preserve a portion of it so it was only necessary to splint the finger until the wound healed. The interphalangeal joint capsule and the cartilages were involved. The patient was pleased with the cosmetic result, volunteering the information that he no longer tried to hide his hand while in public. The photographs show the hand before operation and four months later.

tophaceous swelling. Thomson, quoted by Llewellyn,[5] in 1920, reported two cases in which gouty deposits contiguous to tendon sheaths, bursae and skin were removed. The deposits in one man, age 30, had involved the extensor tendons over the fingers, and in the other, a man, age 37, large tophi were located about the left external malleolus, the left olecranon and the right malleolus. All were subcutaneous except the one about the left malleolus, where bone, ligaments, and peronei tendons were involved. The patients did well following the operations and no further gross tophaceous deposits developed.

A survey was made of the records at the Massachusetts General Hospital from 1835 to 1935, in order to determine how many patients with gout had been operated upon for the treatment of tophaceous deposits. Only seven cases could be found. The operative procedure consisted of evacuating the tophi in three patients, while amputations were carried out on four. The earliest operation was performed in 1878, by Dr. J. C. Warren. It seems difficult to understand why surgery was not performed more frequently in the treatment of deformed tophaceous joints and tophaceous deposits. Perhaps it was because an acute attack of gouty arthritis, with its classical insignia of "tumor, rubor, color, *et dolor*" was so frequently mistaken for an acute infection, and it still is by those not acquainted with the vagaries of gout. Furthermore, it was not realized that considerable relief of symptoms and rehabilitation of the patient could be obtained by surgery.

Diagnosis.—The diagnosis of gout in the tophaceous stage of the disease is not difficult.[10] A history of acute attacks of arthritis with complete relief from symptoms between attacks is usually obtained. If subcutaneous deposits of urate crystals have developed, roentgenograms of the extremities usually will show evidence of bony involvement. The characteristic roentgenologic appearance of a gouty joint includes "punched-out" areas, soft tissue swelling, diminution of joint space, and sometimes extensive destruction of the joint with ankylosis (Figs. 1, 6, 8 and 9). The concentration of uric acid in the blood serum (in contrast to whole blood) is above 6.0 mg. per 100 cc. The serum uric acid is increased between attacks as well as during attacks, and should always be determined in a suspected case of gout. If a sinus has formed in a subcutaneous tophus, the chalky exudate will reveal urate crystals on microscopic examination. A final confirmatory diagnostic procedure is the favorable response to full doses of colchicine if given during an acute attack.

The differential diagnosis between an acute attack of gouty arthritis and joint sepsis warrants *especial consideration.* Undoubtedly, many acute gouty joints have been operated upon because the surgeon considered the condition one of sepsis. This is not surprising, since there may be general as well as local manifestations of a severe infection in acute gout. These include fever, a leukocytosis of 15,000 to 20,000, and prostration. The absence of an ascending lymphangitis from the acutely inflamed gouty joint is a helpful differentiating sign. Fulminating sepsis involving a tophaceous

FIG. 3.—A large tophaceous deposit with a small draining sinus involving the dorsum of the hand. The patient, a male, age 80, had symptoms of gout for seven years. The operation was performed under ether anesthesia. The extensor tendons of the second, third and fourth fingers had to be excised with the tophus because they had been so infiltrated with urate crystals that they were unrecognizable. Despite this, a good functioning hand was obtained by splinting the fingers in extension for eight weeks, then commencing gentle massage and active motion. The drawing shows the incision. A portion of the skin sloughed because of the extensive dissection. This necessitated a secondary skin graft. The photographs show the hand before operation and two and one-half years later, with no evidence of recurrence.

FIG. 4.—A large tophaceous deposit involving the proximal interphalangeal joint of the fifth finger of the right hand and the extensor tendon of it. The patient, a male, age 59, had symptoms of gout for 36 years. The tophus was removed through a transverse incision under novocain block anesthesia at the base of the finger. There was destruction of the proximal end of the middle phalanx and the distal end of the proximal phalanx, with some shortening of the digit which is a little more marked in the postoperative view. The photographs show the hand before operation and one year later, with no evidence of recurrence.

joint is an extremely rare condition, so that immediate surgery in acute gout rarely ever is indicated. Tophaceous deposits about a joint not infrequently rupture through the skin and discharge urate crystals. This may leave an ulcerating lesion (Figs. 3, 5, 6, 7, 8 and 9). Cultures taken from these lesions, in our experience, have shown only the usual bacterial flora found on the normal skin, and in no instances has it been necessary to incise and drain such a lesion. The differentiation between acute gout and sepsis, therefore, should not rest on the local signs and systemic findings but upon a careful evaluation of all of the medical data. An accurate history, with particular reference to previous attacks of joint symptoms, is of utmost importance. An examination of the patient for evidence of tophi elsewhere on the body may give the true diagnosis. Roentgenologic examination of the affected part, and estimations of the blood serum uric acid level in doubtful cases are important diagnostic aids.

Indications for Surgery.—The surgical treatment of gout is applicable only to patients who have developed large tophaceous deposits. Less than ten per cent of all gouty patients studied by the junior author have needed surgical treatment. In the group of patients reported, surgery was limited to the removal of urate deposits which involved the bony and soft structures about the elbows, forearms, wrists, hands, and feet. Elsewhere in the body, especially about the knee joints where very large tophi appear, removal was not found necessary, but if the occasion should arise they could be similarly treated. The indications for surgical treatment are believed to be: (1) Cosmetic reasons when tophi have become large and unsightly, such as in the subcutaneous tissues of the fingers, the dorsum of the hand, forearm, or wrist (Figs. 1, 2, 3, 4 and 5). In this category may be included smaller tophi on the hands and feet which interfere with the wearing of gloves and shoes. (2) Pain in tophi because of their location over exposed areas of the body, such as those involving the olecranon bursae, knuckles, terminal ends of the fingers, toes and heels (Figs. 2, 4, 6, 8, 9 and 16). (3) Interference with the movements of tendons or adjacent joints by tophi that involve the extensor or flexor tendons of the hand (Figs. 5 and 11). (4) Any discharging sinus associated with a tophaceous deposit (Figs. 3, 5, 6, 7, 8, 9 and 16). (5) Extensive phalangeal involvement of the fingers or toes with urate deposits (Figs. 1 and 9).

Surgical Pathology.—The tophaceous deposits which were removed during this study may be divided into three anatomic types: (1) bursae and subcutaneous deposits which have involved only the tissues superficial to the deep fascia; (2) deposits which arise in tendons and which may or may not have involved adjacent tissues, such as fat, fascia, bursae, and skin; and (3) deposits which arise in joints with involvement of the bones, tendons, bursae, subcutaneous tissues, and skin.

All of the tophi involving the soft tissues had a definite fibrous capsule, which was thin and transparent but tough (Figs. 11, 12, 15 and 16). It is thought to be formed from connective tissue and is, therefore, not a

FIG. 5.—A large tophaceous deposit, with draining sinuses on the dorsum of the right hand. The patient, a male, age 65, had symptoms of gout for 20 years (The same patient as in Fig. 8). The roentgenogram shows ankylosis of the proximal interphalangeal joint, with little bone destruction. The operation was performed under ether anesthesia. The extensor tendon was so infiltrated with urate crystals that it was necessary to remove it from the base of the metacarpal bone to the base of the terminal phalanx. Despite this, excellent function was restored by splinting the finger in extension for eight weeks, then commencing gentle massage and active motion. This was one of the earliest cases operated upon using a longitudinal incision as shown in the drawing, which resulted in marked sloughing of the skin flaps necessitating a secondary skin graft. Multiple transverse incisions would have obviated this complication. The photographs show the hand before operation and two years later, with no evidence of recurrence.

true capsule. The formation of it is considered to take place with the deposition of urate crystals in the tissues. As the tophus gradually increases in size it replaces the subcutaneous fat and forces aside the fibrous connective tissue, thus forming a capsule. Some of the fibrous tissue may be infiltrated with urate crystals instead of being forced aside since on the cross-section of a tophus a stroma of interlacing fibers may be seen dividing it into numerous lobules (Fig. 12). The lobulated appearance is evident on the surface of all cleanly dissected tophi in which the capsule is intact (Figs. 11, 12, 15 and 16). The urate crystals rarely infiltrate through the subcutaneous tissues. When this occurred it was thought to have followed rupture of the capsule due to trauma or an acute attack of gout, when the contents of the tophus may be partially fluid and under considerable tension. When bones or tendons were involved a capsule was not encountered unless the urate crystals had pushed out into the soft tissues surrounding these structures. It is of interest to note that the urate crystals did not invade blood vessels or nerves, although they often surrounded them. Tendons, on the other hand, were very frequently infiltrated with urate crystals and in some instances so complete was the replacement with urate crystals that no tendinous structure could be recognized.

Tophaceous deposits of long standing were found to be very dry and chalk-like on cross-section (Fig. 12). If there had been a recent attack of acute gout, the urate crystals were suspended in a fluid which gave the appearance of pus. It is believed that the pain in a tophaceous deposit associated with an acute attack of gout may result from the tension produced by the rapid deposition of urate crystals in a semifluid state within the relatively nonyielding fibrous capsule of the tophus. Evidence in favor of this theory is the fact that when a tophus was decompressed by partial excision of the capsule and evacuation of the contents the patient was relieved of pain even though the urate crystals were not completely removed. The relief of pain following the spontaneous rupture of a tophus adds support to this theory.

Analysis of Operations.—The operations were carried out over a seven-year period, 1935 to 1941, inclusive. Forty-six operative procedures were undertaken on 11 patients. Several tophaceous deposits were removed at one operation in many instances. The number of operations per patient varied from one to ten. Six patients had five or more, three had one, one had three, and another two. The operations were divided equally between the hands and feet. There were 41 operations on the feet and toes, 40 on the hands and nine on the forearms and elbows. Local anesthesia, with one per cent novocain solution, was employed in 24, ether in nine, spinal anesthesia in 12, and no anesthesia in one.

An analysis of the lesions shows that there were 31 subcutaneous tophi, 36 involving tendons and adjacent structures, and 26 which arose from joints with bone and soft tissue invasion. Further analysis of the statistics shows that in the subcutaneous group there were eight on the fingers, most fre-

FIG. 6.—Tophaceous deposits involving the first metatarsophalangeal joints of both feet and the left heel. The patient, a male, age 55, had symptoms of gout for 26 years (The same patient as in Figs. 10 and 16). The operation was performed under spinal anesthesia. Note the draining sinuses in the tophus of the heel. Roentgenograms of the feet show some destruction of the proximal phalanges and the first metatarsal bones, but most of the articular surfaces were intact, so that the great toes were not amputated. The drawing shows the incisions employed. The photographs show the lesions before surgery and the left foot two years and the right foot and left heel one year later, with no evidence of recurrence.

FIG. 7.—Tophaceous deposits on the lateral side of the feet. On the right foot the skin was intact but on the left there was a large ulceration with urate crystals visible in the center. The patient, a male, age 70, had symptoms of gout for 30 years. The tophi involved the peronei tendons at their insertions into the tarsus. The operations were performed under spinal anesthesia. The deposits were excised with the overlying skin (see drawing). The tendinous structures were preserved by curettage of the urate crystals. Thiersch skin grafts were applied to the denuded areas, resulting in well healed wounds. The patient thereafter was able to wear his regular type of shoe without discomfort. The photographs show the feet before operation and two years later, with no evidence of recurrence.

quently on the flexor surface, three on the forearms, four involving the olecranon bursae, seven on the toes, eight on the heels, and one on the lateral side of the foot. There were 13 extensor tendons of the fingers and thumbs operated upon, 12 extensors of the toes, four extensors on the dorsum of the hands, two flexors of the fingers, one flexor in the palm of the hand, two triceps tendons, one tibialis anticus tendon, and two involving the peronei tendons at their insertion on the tarsus. The cases with joint, bone and soft tissue involvement included 12 fingers, some with metacarpal involvement, 14 toes, six of which had involvement of the metatarsophalangeal joints, five being of the great toe, the typical location for gout to manifest itself. It is of interest to note that of the 93 tophaceous deposits operated upon only approximately five per cent occurred at this latter site.

Operative Technic.—The successful operative results are attributed to meticulous surgical technic and the adherence to certain rules that evolved during the study. The incidence of arteriosclerosis among gouty patients both young and old is an important factor to be considered. Great care must be taken to maintain an adequate blood supply, particularly in the lower extremities. Incisions should be made so that when closed they will not be subjected to unnecessary tension lest sloughing of the skin occurs. Arterial tourniquets were employed on the finger operations, using a rubber band at the base, but they are contraindicated for operations carried out on the feet because they may damage an arteriosclerotic artery sufficiently to produce arterial thrombosis, with resulting gangrene of the foot. The carrying out of surgery by the most atraumatic method possible cannot be overemphasized.

A tophaceous deposit may be removed by one of two methods. Complete excision of the tophus with its surrounding capsule is preferable. This procedure was followed for all of the large tophi in the soft tissues, such as the olecranon bursa (Fig. 16), subcutaneous tissues of the forearm, hand, and foot where tendons were not involved. Curettage with a small bone curette was the second method. This procedure was used for the removal of the small subcutaneous tophi after making an incision through the overlying skin. If the tophaceous deposit involved the bones or tendinous structures, such as the triceps tendon or a flexor tendon, the major part of the tophus was excised and the remainder was removed by curettage in order not to destroy important structures (Figs. 11, 15 and 16).

The surgical procedures on the hands were, of necessity, more conservative than those on the feet. It is important to preserve the fingers in spite of extensive urate infiltration (Fig. 1). One badly involved finger was amputated early in the study, but as more cases were encountered it was found unnecessary to sacrifice these digits despite extensive urate deposits in the tendons and phalanges, since removal of the tophi resulted in relief of pain, improved cosmetic appearance and partial rehabilitation. The periosteum and bony shell of a phalanx was preserved insofar as was possible. The situation in many cases appeared hopeless when judged roentgenologically (Fig. 1), but a significant quantity of bony shell and periosteum

FIG. 8.—Extensive tophaceous deposits of all toes with marked involvement of the metatarsophalangeal joints of the great toes, the terminal phalanges of the other toes, and one in the tibialis anticus tendon of the left foot (marked by an arrow). The patient, a male, age 65, had symptoms of gout for 20 years (The same patient as in Fig. 5). The right great toe had been amputated several years previously at another hospital, but the wound had never healed because the removal of the disease was not sufficiently radical. The draining sinus is seen in the preoperative photograph. The operations were performed under ether anesthesia. The head of the right first metatarsal, the left great toe and the head of the first metatarsal, and the left fifth toe and the head of the fifth metatarsal were amputated through racquet-type incisions. The remaining toes were amputated through the base of the proximal phalanges using lateral skin flaps. This patient and one other were the only ones upon whom such radical surgery was carried out. Both patients obtained excellent results, as they were able to walk without pain. They used the specially constructed type of shoe shown in Figure 13, which permitted them to walk with a normal gait. The photographs show the feet before operation and two years later, with no evidence of recurrence.

would be found at operation. If this could be saved a useful finger was obtained despite the fact that the interphalangeal joints were destroyed.

Removal of the tophaceous deposits involving the toes without amputation also is recommended if roentgenologic examination reveals any of the joint surfaces of the phalanges or metatarsals to be intact (Figs. 6 and 9). When there was marked destruction of these bones (Fig. 8) the treatment of choice was amputation through the proximal phalanx, using lateral skin flaps. If the first or fifth toes were amputated the head of the metatarsal was removed with it, using a racquet-type of incision (Fig. 8). The end-results justified these procedures, since the patients were able to walk in comfort and with practically a normal gait, instead of being limited to a wheel-chair existence. All the toes were removed in a few patients, and despite such radical surgery the rehabilitation of the patient was very gratifying. A specially constructed shoe was developed for these patients which had a forked shank of steel incorporated in the layers of the sole (Fig. 13). The shank is almost as long as the foot before amputation of the toes. This type of shoe allows a spring to the patient's gait which otherwise would be lacking.

If a tophaceous deposit involved an important tendon, such as a flexor tendon of a finger (Fig. 11), the tibialis anticus (Fig 8), or a triceps tendon (Fig. 16), it was deemed important to remove the tophus leaving as much as possible of the tendon. When the extensor tendons of the fingers were involved, either over the digits themselves or the dorsum of the hand, it was impossible to recognize the tendons in many cases so that the remnants of them had to be sacrificed. Despite this, with careful postoperative splinting and rehabilitation, the majority recovered the use and function of fingers and hands. The extensor tendons of the second, third, and fourth fingers on the dorsum of the hand were removed in one patient. Nevertheless, he obtained a very serviceable hand (Fig. 3).

Every precaution was taken to prevent trauma to the parchment-thin skin which overlies many tophi. Sharp scalpel dissection was used to dissect it from the tophaceous deposit. The skin was retracted by means of sutures in the skin edges and as the dissection was carried toward the base of the tophus fine rake retractors were used. The incision was closed with vertical mattress sutures of silk to prevent infolding of the edges. A plaster splint was applied for immobilization whenever a tendon or a joint was involved. The first dressings were usually done in ten days to two weeks. The skin sutures were removed at that time.

FIG. 9.—Tophaceous deposits involving the toes. The patient, a male, age 69, had symptoms of gout for 15 years (The same patient as in Fig. 2). The third toe on the right foot had been amputated two years previously by another surgeon because of a painful tophaceous deposit involving it. The roentgenograms show marked destruction of the terminal phalanges in the left and right first and second toes and the left third and fourth toes. There was also a large tophus involving the right metatarsophalangeal joint. The skin was ulcerated over the tophus on the left great toe, which had necessitated daily dressings for many months. The urate crystals can be seen in the base of the ulceration and through the parchment-thin skin over the other tophi. Through transverse incisions, as demonstrated in the drawing, all these deposits were removed under spinal anesthesia at one operation. The wounds healed *per primam*. Amputation of the toes was not considered necessary because the tophi were chiefly in the distal ends of the digits and the metatarsophalangeal joints were relatively uninvolved. The photographs show the feet before operation and four months later.

The types of incisions which were used are of extreme importance, especially on the fingers and toes. The first operation for the removal of a tophaceous deposit on a finger was undertaken through lateral incisions, one on either side of the finger. This gave an adequate exposure and it was possible to remove the urate crystals without difficulty. The skin between the two incisions sloughed, unfortunately, and the wound healed by secondary

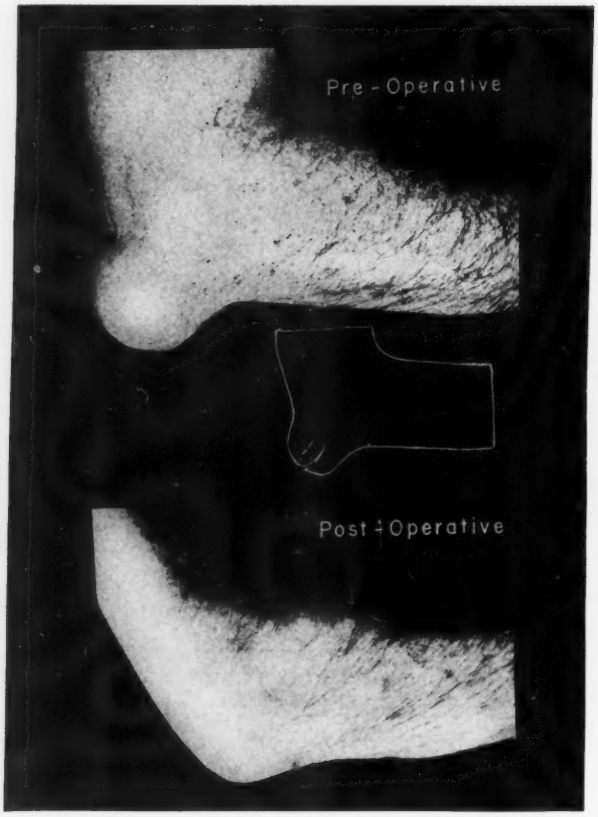


FIG. 10.—A large tophus of the elbow involving the olecranon bursa and the insertion of the triceps tendon. The patient, a male, age 55, had symptoms of gout for 26 years (The same patient as in Figs. 6 and 16). The operation was performed under ether anesthesia. The urate crystals were curetted from the tendon in order to preserve the attachment of this important structure. The drawing shows the incision. The photographs show the elbow before operation and one year later, with no evidence of recurrence.

intention. Early in the series another large tophaceous deposit, which extended from the base of the third metacarpal to the base of the terminal phalanx on the dorsum of the hand (Fig. 5), was removed through a long incision extending over the entire length of the tophus. It was necessary to remove the extensor tendon with the tophaceous deposit because it had been practically destroyed by infiltration with urate crystals. Once again, the skin edges of the wound sloughed and it was necessary to do a secondary

skin graft in order to heal the wound. A satisfactory result was obtained but it required several additional weeks (Fig. 5).

Following this incident all tophaceous deposits on the fingers, hands, toes and feet were removed through single or multiple transverse incisions. Care was taken to avoid severing the digital arteries. Sloughing of the skin edges was never a factor after this type of incision was adopted. Similar

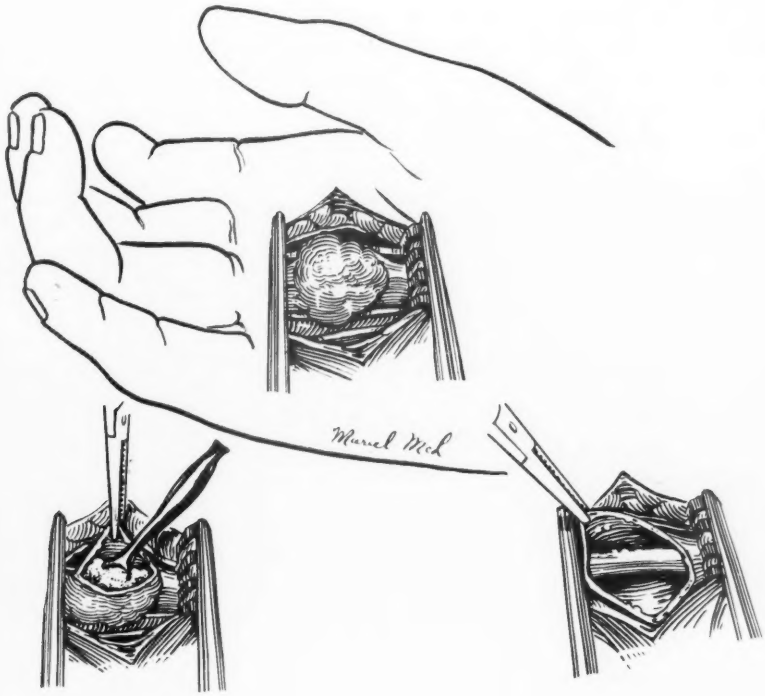
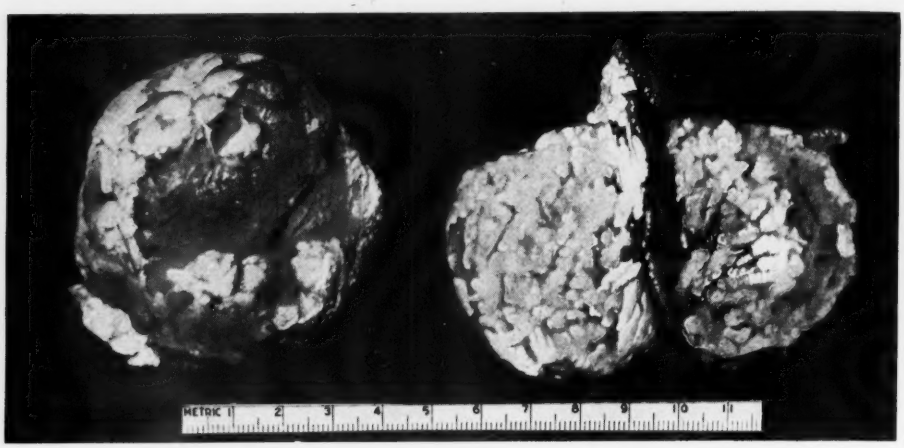


FIG. 11.—A drawing showing a tophaceous deposit in the flexor profundus tendon of the left fourth finger in the palm of the hand. The patient, a male, age 28, had symptoms of gout for seven years. The tophus prevented complete extension of the finger. The operation was performed under local anesthesia, through a transverse incision. The tophus was limited to the tendon. It was lobulated and covered with a thin capsule. The removal was accomplished mainly with a curette in order to avoid excising too much of the tendon. Since so much of the tendon was involved complete removal was impossible for fear the tendon would rupture. As a result, the tophus recurred and a second operation was performed two years later, at which time a more radical removal was attempted. Again, three years later there is only slight evidence of recurrence but no interference with flexion of the finger. The patient is one of the youngest in the group and has the most marked and disabling tophaceous deposits involving practically all of his joints.

transverse incisions in the cleavage planes of the skin were used for the removal of the olecranon bursae or tophaceous deposits in the forearms, wrists and heels. It was found most satisfactory to incise the skin directly over the tophaceous deposits (Figs. 15 and 16) rather than to make the incision at the base of them in sound skin, as advised by Lindsay.[4]

The treatment of ulcerating tophaceous deposits which involved the first or fifth metatarsophalangeal joint of the foot was most satisfactory by amputation of the toe through the body of the metatarsal bone. The in-

cision was a racquet-type which extended around the base of the toe and up along the inner or outer side of the foot in order to expose the metatarsal bone (Fig. 8). It was possible to circumvent any ulcerated lesion on the side of the joint with this type of incision and when closure was made there was adequate skin to close the wound without tension. The metatarsal was divided either at the middle or junction of the middle and distal thirds in most instances (Fig. 8). This was necessary usually because of extensive involvement of the marrow cavity with urate crystals. The sesamoid bones were always removed when this procedure was carried out. If the remaining toes were involved, these were usually amputated through the proximal phalanx, leaving only a small portion of the base (Fig. 8). Lateral skin flaps were used because the blood supply to these is more adequate than



A B

FIG. 12.—A large tophaceous deposit excised from the subcutaneous tissues of the heel. The patient, a male, age 55, had symptoms of gout 26 years (The same patient as in Figs. 6, 10 and 16). A. Note the lobulated appearance of the tophus which is covered with a thin transparent capsule. B. The cross-section of the tophus shows the chalk-like appearance and the stroma of interlacing fibers of connective tissue dividing it up into numerous lobules.

the anterior or posterior flaps. The involvement of the first metatarsophalangeal joint with destruction of the proximal phalanx and the first metatarsal bone was less extensive in some of the cases. When there was no ulceration of the overlying skin the tophus was exposed through a transverse incision (Fig. 16). The greater part of it was cut away with a scalpel and the remainder removed by curettage. It was possible by this means to remove practically all of the tophaceous deposit without sacrificing the great toe although it had destroyed the major part of the joint and completely surrounded it pushing aside tendons, nerves and blood vessels. The results obtained in these cases were very gratifying (Figs. 6 and 9).

A large residual cavity was unavoidable following the removal of a tophaceous deposit that had destroyed a joint. This always filled with blood (Fig. 15) which either organized eventually to form a fibrous union between the bones, or ossified and ankylosed. If the bony destruction was

marked there was considerable shortening of the digit after healing (Figs. 1 and 4). Postoperative drainage was unnecessary and even is considered contraindicated in these cases.

Ulcerating tophaceous lesions were encountered on the lateral side of the foot in some patients (Fig. 7). The method of handling this type of lesion was different than the others. Since it was impossible to remove the tophus without interfering with the blood supply of the overlying skin this was excised with the tophaceous deposit. The urate crystals in such cases had usually invaded the tendinous structures of the foot so that it was necessary to complete the removal by curettage. A large raw surface several centimeters in diameter remained which would have taken many weeks to epithelialize. Healing was hastened by suturing a Thiersch skin graft over the raw surface. A very satisfactory "take" followed each instance this was

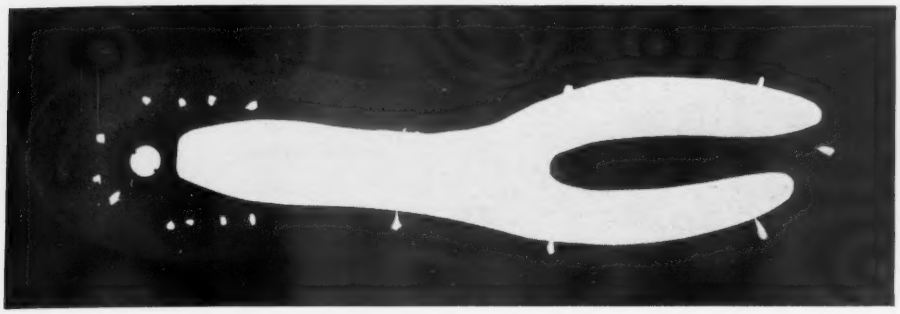


FIG. 13.—An anteroposterior roentgenographic view of the specially constructed shoe worn by the patients who had all their toes amputated for extensive tophaceous deposits. Note the forked shank of steel which is incorporated in the sole of the shoe. The shank is almost as long as the foot before amputation of the toes. This permits a spring to the patients' gait which otherwise would be lacking.

attempted. The cosmetic result (Fig. 7) was excellent and the patient received complete relief from the troublesome deposits and ulcerated lesions.

Wound Healing in Gout.—Surgical wounds in gouty patients heal exceptionally well. Ninety-three separate incisions were made in 46 operative procedures that were carried out on the 11 patients. Sepsis developed in three wounds only, and in each of them preoperative ulceration was present. The tophi had ulcerated through the skin so that operations of necessity had to be performed in the presence of infection. The sepsis was only superficial and followed removal of a tophaceous deposit involving the extensor tendons of the fingers. Two of the cases were among the earliest ones done in the period in which longitudinal skin incisions were used. It is believed that this played a part in the wound breaking down. In the third case the largest tophus of the series was removed from the dorsum of the hand, which involved all of the extensor tendons of the fingers with the exception of the thumb and fifth finger. The tophus was open and had established a sinus through the skin (Fig. 3). The removal of it necessitated such an extensive dissection of the skin overlying the tophus that its blood supply was impaired. This led to a partial slough which later required

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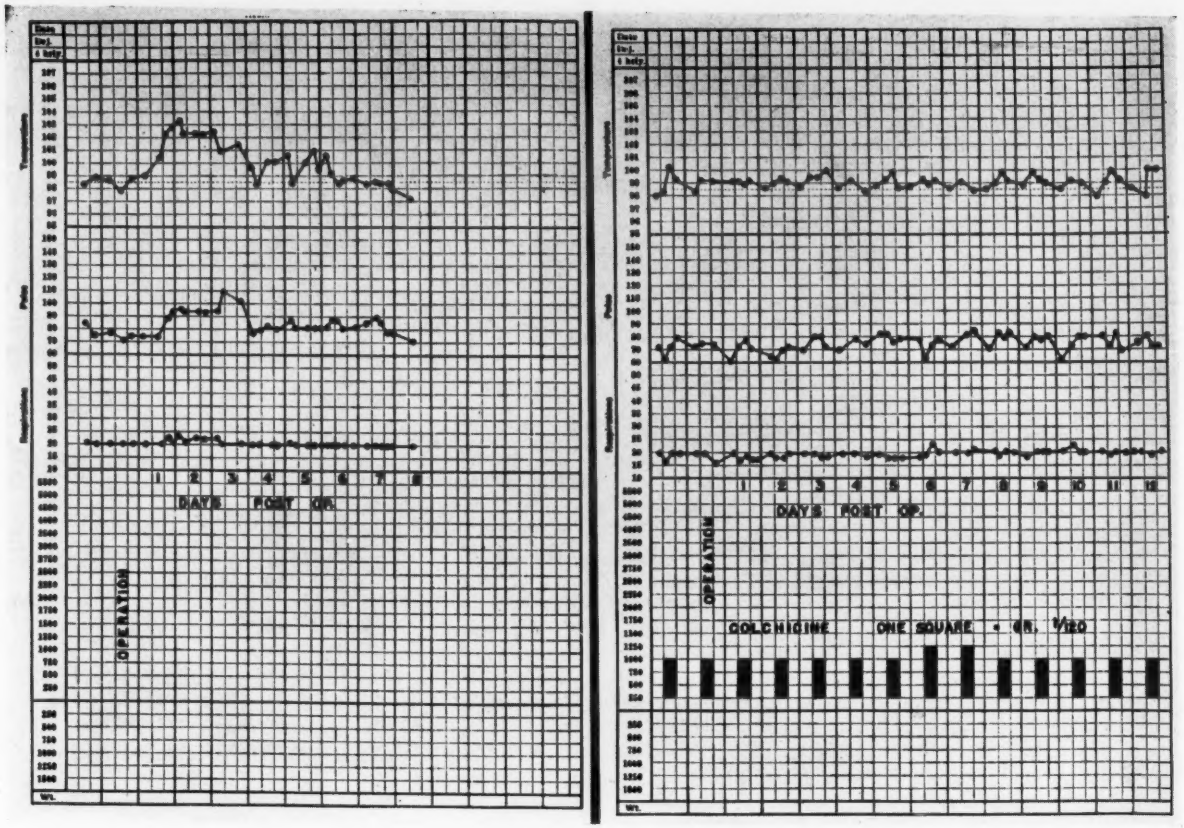


A B

FIG. 14.—A. The temperature, pulse and respiration chart before and after the excision of a small tophaceous deposit on the foot, under spinal anesthesia, without administration of colchicine either preoperatively or postoperatively. The patient, a male, age 62, had symptoms of gout for 20 years. Note the marked rise in temperature beginning on the first postoperative day. This was accompanied with acute joint symptoms characteristic of an acute attack of gout. The operative wound healed *per primam*, with no evidence of sepsis. B. The temperature, pulse and respiration chart before and after the removal of extensive tophaceous deposits in two fingers, under local anesthesia. The patient, a female, age 49, had symptoms of gout for 32 years. She received colchicine 1/120 grain three times a day preoperatively and postoperatively. Note the absence of any postoperative febrile reaction and, clinically, there were no signs of acute gout.

a skin graft. In two of the cases with postoperative sepsis there was bony involvement, yet no serious consequences resulted. It is worthy of note that five other cases were operated upon with open lesions, all of which healed *per primam*. The local application of sulfanilamide in the operative wounds was not used in this series of operations, but it is felt that its use would be an additional safeguard especially in cases with draining sinuses. The excellent wound healing in this group of cases suggests that sodium biurate crystals may have a bacteriostatic action since it was impossible to remove all of them from the operative wounds except in well encapsulated subcutaneous tophi. These good results do not mean that a surgeon can operate upon gouty patients as if they were normal healthy individuals but the above statistics show that one is justified in attempting to relieve patients with painful tophi without any great risk of serious infection. The only serious case of sepsis developed in the finger of one of the patients following an incision and drainage of the tophus by his local doctor, who misdiagnosed an attack of acute gout as sepsis. Neither the physician nor the patient recognized the acute attack and the incised wound was left open. This became infected subsequently and an open amputation of the finger through the proximal phalanx was required.

Postoperative Gouty Attacks.—An interesting complication may confuse the postoperative course of a gouty patient. It is not unusual on examining the clinical records of patients either with recognized or unrecognized gout to note that an unexplained fever and leukocytosis (Fig. 14) appeared on the second or third postoperative day. If the operation involved joints or was adjacent to articular structures, acute joint symptoms were prone to be attributed to the operation. If the operation was unrelated to gouty deposits the acute joint symptoms were apt to be overlooked. It is not widely appreciated that an acute attack of gout may follow any operative procedure in a gouty patient. Articular or nonarticular structures may be the site of operation. The attack may appear within 24 hours after operation or it may follow an interval of as long as a week. The attack may be monarticular or polyarticular and indistinguishable from an acute attack of gouty arthritis not related to an operative procedure.

In reviewing the records of 100 patients with gout, there were 22 operations in which no attempt was made to avert the development of postoperative gouty arthritis. The operations included a dissection of the neck for carcinoma of the esophagus, partial colectomy, radical excision of a myosarcoma of the thigh, and a Thiersch graft of the skin. The incidence of postoperative gout following this series of operations was 86 per cent. In an attempt to reduce this percentage, the ingestion of a few colchicine tablets immediately following operation was practiced. This proved successful in many instances, but eventually was extended to include preoperative as well as postoperative ingestion. At present, the routine procedure is to give three colchicine tablets ($\frac{1}{120}$ gr. each) a day for two days before operation and a similar quantity for three or more days following operation (Fig. 14).

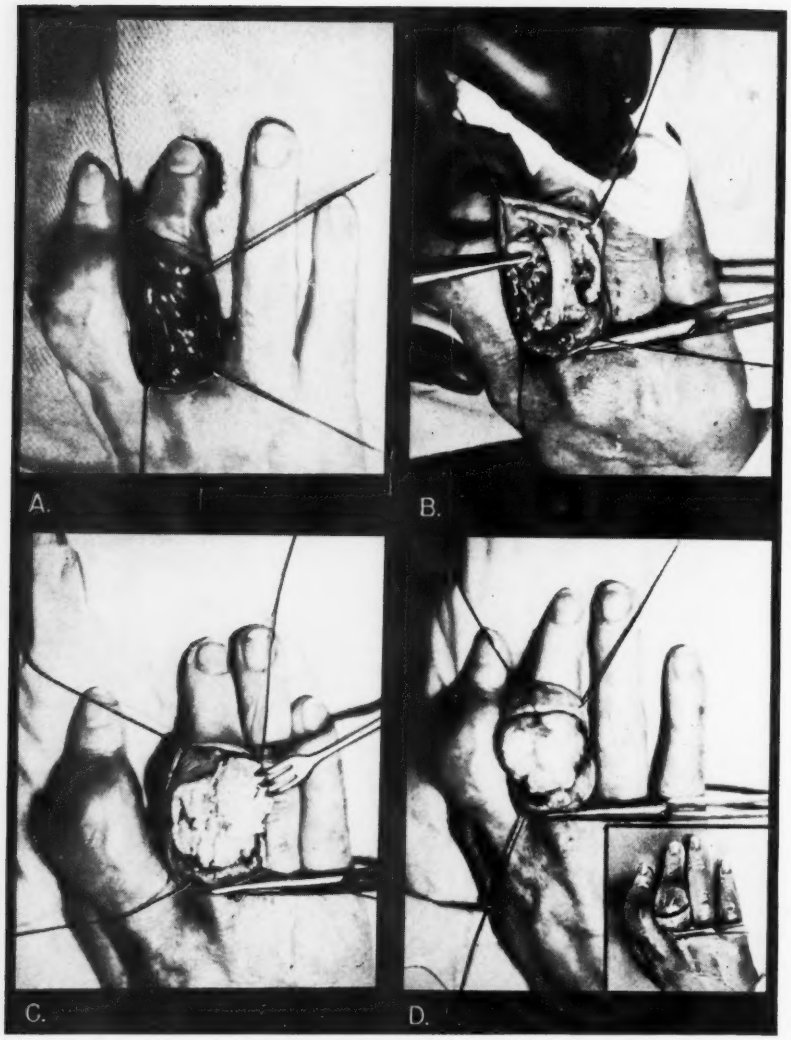
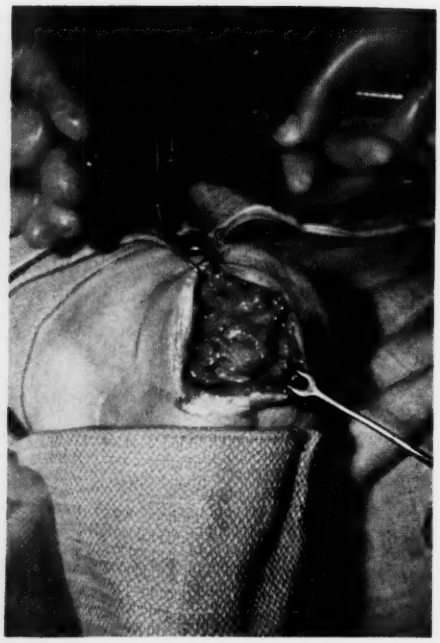


FIG. 15.—Photographs of the operative removal of an extensive tophaceous deposit involving the phalanges and tendons of the middle finger of the right hand. The patient, a female, age 49, had symptoms of gout 32 years (The same patient as in Fig. 1). The operation was performed under novocain block anesthesia at the base of the finger. (A) The skin over the tophaceous deposit has been incised, employing a transverse incision. It was dissected from the deposit with a scalpel and retracted with silk sutures. A rubber tourniquet at the base of the finger, held with the hemostat, prevented bleeding and permitted a careful dissection. Note the thin capsule of the tophus and its lobulated appearance. (B) The main mass of the tophaceous deposit has been partly freed up and pulled aside with the rake retractor. (C) More of the tophaceous deposit has been removed exposing the extensor tendon which was infiltrated with urate crystals and buried beneath the main mass of the tophus. The portion shown was preserved. The cavity beneath it represents the joint space. A considerable portion of the adjacent phalanges have been destroyed by the tophaceous deposit, leaving a large dead space after removal of the urate crystals. (D) The tourniquet has been removed. Note the free bleeding which has occurred. The skin was closed with interrupted vertical mattress sutures of silk.

A

B



C

D

FIG. 16.—The excision of large tophaceous deposits involving the left heel, the right elbow and the right first metatarsophalangeal joint. The patient, a male, age 55, had symptoms of gout for 26 years (The same patient as in Figs. 6 and 10). A. A lateral view of the heel to show the tophaceous deposit. A large piece of desquamating epidermis has been peeled downward, showing the large subcutaneous tophaceous deposit. Note the lobulated appearance of the mass and the urate crystals showing at the base of the ulcerated areas. B. The main mass of the tophus has been resected through a transverse incision, excising the ulcerated areas in the skin. The base of the wound shows normal appearing subcutaneous tissues. This tophaceous deposit did not involve a tendon or bone but lay in the subcutaneous tissues of the heel. The wound was closed with interrupted silk sutures, without drainage. The foot was immobilized in a posterior plaster shell for two weeks. The wound healed *per primam*. An excellent result was obtained (see Fig. 6). C. The skin over the olecranon has been opened through a transverse incision. The tophaceous deposit filling the olecranon bursa has been dissected from the overlying skin and the tissues beneath it and retracted downward with forceps. Note the separate deposit involving the triceps tendon in the lower portion of the wound.

E

F

G

H

D. The dissection has been carried down to the triceps tendon from which most of the tophus has been dissected away with the scalpel and curette. Some urate crystals are to be seen in the tendon. It was necessary to leave these because they had infiltrated the tendinous structure to such a degree that complete removal of them would have destroyed the attachment of the triceps tendon. The wound was closed with interrupted sutures without drainage. The elbow was immobilized with a posterior plaster splint for ten days. The wound healed *per primam*. An excellent result was obtained (see Fig. 10). E. The skin directly over the tophaceous deposit of the first metatarsophalangeal joint has been opened through a transverse incision exposing the capsule of the tophus. The skin was dissected free with a scalpel, and silk sutures in the edges were introduced for retraction to prevent undue trauma to the parchment-thin skin. The lobulations of the tophus can be seen through the capsule. F. A large section of the deposit has been cut away with a scalpel, which still left a large amount of urate crystals about the bones and joint. G. The remainder of the tophus involving the base of the phalanx and the head of the metatarsal bone, and an extension of it over the dorsum of the joint to the outer side of the toe, was removed with a bone curette. The capsule of the joint was markedly infiltrated with the urate crystals, so that removal of it opened the joint space. Most of the joint cartilage and the articular ends of the bones had been destroyed but sufficient of them were intact, so that it was not felt necessary to amputate the toe. H. The wound was thoroughly flushed with normal saline solution and the skin approximated with interrupted vertical mattress sutures of fine silk, without drainage. Note the depression where the tophus had been. This cavity filled with blood clot, which became organized, resulting in a normal contour to the foot when healed (see Fig. 6). The foot and ankle were immobilized in a padded posterior plaster shell for two weeks. The wound healed *per primam*.

For this reason it was found advantageous to use local anesthesia wherever possible. Thirty-three operations in all have been performed using colchicine in prophylactic doses. The incidence of postoperative gout, in contrast to the 86 per cent among untreated patients, was only ten per cent. Gout developed in one patient who had had preoperative colchicine but not postoperatively; one had it postoperatively but not preoperatively; and one had it both preoperatively and postoperatively. It is obvious from these data that the adequate use of colchicine not only gives peace of mind to the surgeon, but comfort to the patient in the postoperative period. If a patient suddenly develops a fever in the first week following an operation, it is important to know that such a reaction not uncommonly may occur in patients with gout. More important is the recognition of the fact that it is possible to prevent attacks of postoperative gouty arthritis with adequate amounts of colchicine.

The type of anesthesia seemed to have little if any effect on the postoperative attack of gout. In this series local anesthesia with one per cent novocain infiltration was used in 24, ether in nine, spinal anesthesia in 12, and no anesthesia in one. Six of the 13 postoperative attacks of acute gout followed local anesthesia, three followed spinal anesthesia, and four followed ether anesthesia. The preponderance of cases following local anesthesia is explained by the fact that the majority of the patients received local anesthesia for their operation.

Follow-up Studies.—The follow-up studies carried out in June, 1942, or up to the death of the patients, showed that in only three out of the 93 tophaceous deposits were recurrences of any size observed. One of these was in the finger of a woman with very extensive deposits in which an inadequate removal was done at the first operation. In the second case a tophus recurred in the flexor tendon in the palm of the hand because removal had been incomplete from fear of destroying the tendon. The third case had a recurrence in the finger and was one of the earlier operations in which complete removal of the tophaceous deposit had not been obtained. The explanation of why tophi do not recur after simply removing the urate acid crystals is not offered.

Relief from pain was obtained by the surgical removal of the tophaceous deposits in all of the 11 patients. Four patients with extensive involvement of the feet, who were unable to walk without extreme pain or not at all, were rehabilitated so that they could get about without pain. Eight of the patients had painful tophi removed from the hands and fingers with marked relief of symptoms and in some with considerable restoration of function. In addition the improvement in the appearance of hands was very marked.

It is hoped that the results published in this paper will encourage others to undertake surgery in similarly afflicted gouty patients. Since this series of cases show that good results are possible by the surgical removal of tophaceous deposits, even late in life, it is recommended that surgery be done earlier in the course of the disease than usually is considered desirable.

CONCLUSIONS

1. The surgical removal of tophaceous deposits in 11 patients with gout is reported.

2. Tophaceous deposits, as a rule, primarily involve joints and secondarily tendons, bones and soft tissues, but also they may occur primarily in tendons and subcutaneous tissues.

3. Carefully planned and staged-operations may be carried out on patients with gout which result in the relief of pain, restoration of function, rehabilitation of the patient, improved cosmetic appearance, and in many instances permanent eradication of the tophaceous deposits.

4. Adequate preoperative and postoperative treatment of the patient with colchicine is essential.

5. Close cooperation between the surgeon and the internist in the selection and care of these patients is vital.

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TOTAL GASTRECTOMY FOR CANCER*

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THE CURE OF GASTRIC CANCER can only be achieved by surgical intervention. This end can not always be attained by mere partial resection of this organ, on account of the location of the neoplastic process or the extension of the involved area, in which case other procedures are to be contemplated, such as esophagogastrectomy or total gastrectomy.

The idea of performing a total removal of the stomach is not a new one: Already, in 1875, Czerny hinted at this possibility, which was put into practice in 1883 by the American surgeon Connor, that is, three years after Billroth had started the surgical era in the treatment of gastric cancer when he successfuly performed his famed operation of a partial gastric resection. His patient died shortly after the procedure was ended, and fourteen years had to elapse before Schlatter would perform the first total gastrectomy, followed by temporary cure. Since that time there have appeared several publications, in the greatest majority of single cases or small statistics about this operation. It may be said that this procedure belongs to our day, inasmuch as it is only in the last four or five years that medical centers specialized in gastric cancer have placed it where it deserves to be. Up to date, there are about 240 total gastrectomies recorded in the literature; but this figure does not correspond nearly to the actual number of operations performed. Suffice it to say that 55 of them have been performed at the Lahey Clinic, while at the Massachusetts General Hospital this figure goes up to nearly 80. Even so, it is our feeling that it is not performed as frequently as it should be, which might be accounted for by the fact that patients suffering from this disease are treated at any surgical or medical center and not in specialized institutions, as it should be, and where they have more precise knowledge and judgment about the indications and technic of the operation.

Let us review the physiopathologic and clinical bases that justify its performance. It is a well proved fact in humans, as well as in experimental animals, that the stomach is not an indispensable organ for the life of the individual. The function of reservoir for ingested food and its normal emptying is adequately filled by the jejunal loop, and as soon as adaptation to the new function takes place, patients can be fed. With certain restrictions, they put on weight and lead a normal life. The gastric secretions are not indispensable for the digestion and absorption of alimentary principles to occur in a proper way, provided that the patient or animal that has undergone the procedure be supplied with them in the proper amount and quality.

* Read before the New York Surgical Society, November 25, 1942.

As far as the chlorhydropeptic action is concerned, it has been proved in a most convincing manner that their simple exclusion from gastric secretion does not seriously affect the physiologic digestion of albumin, fats and carbohydrates. It has been stated that the lack of the stomach fatally induces pernicious or secondary anemia. The experiments of Ivy, Mann, Graham, and others have shown that extirpation of the stomach is not followed by anemia, a fact that could be verified as late as four years after total gastrectomy had been performed. On the other hand, clinical experience teaches us that secondary anemia is not frequent, or so much so as following partial gastrectomy, and that the cases which showed severe anemia always had secondary metastases with fatal termination. We know only the one instance of Moynihan's whose patient had a postoperative survival of three years and seven months and who died showing symptoms of pernicious anemia, postmortem examination having failed to show any evidence of recurrent or metastatic cancer. The investigations of Castle and Locke, and others, enable us to state that there is no physiopathologic base to support such assumptions. They have demonstrated that in the stomach, but specially in the duodenum, certain substances are generated (intrinsic factor) which, in the face of alimentary proteins (extrinsic factor) give rise to the formation of certain materials (erythropoietic factor) which are responsible for red blood cell formation. Mere sparing of duodenal mucosa, as is the case when stomach is partially or completely resected, would, therefore, suffice to prevent anemia. It is obvious that the latter is apt to occur in gastrectomized patients since it may occur in nonoperated individuals, the former showing a greater predisposition for this condition than nonoperated subjects. It might well happen that before the operation the patient would be in a state of equilibrium in which pernicious anemia would not occur because gastric mucosa supplied the part of intrinsic factor that for some reason the duodenum was not able to produce: Gastrectomy would break this equilibrium and pernicious anemia would develop since the duodenal factor proves to be insufficient. This is our possible explanation of the above mentioned instance of Moynihan's patient.

Other serious objections have been made to total gastrectomy: That the mortality is very high, that the greatest majority of those who survive die very shortly after, due to recurrence, and that the very few that are spared from both the operation and the recurrence never lead a normal life due to dietary restrictions to which they are submitted. According to the first publications operative mortality has been around 50 per cent or more. However, the last ones we have been able to consult, as well as the verbal communications from surgeons in this country, specialized in this field, show that as the surgeon gets more acquainted with the operation, improves his technic and the methods of anesthesia as well as the pre- and postoperative care of the patients and, above all, when he learns to select those cases in which operation should be performed, those high mortality rate figures have

come down in a very significant proportion. In other words, the history of the mortality rate with partial gastric resection has been repeated in the case of total gastrectomy. It is estimated to be now about 15 per cent in the Lahey Clinic; and it is as low a figure as that that I have been given by Dr. Pack through his experience at the Memorial Hospital. In our own experience, the mortality has gradually decreased and in the last four, only one patient died from bronchopneumonia. These facts, together with the truism that gastric cancer untreated, or treated by other means than surgery, ends by death in 100 per cent of cases, entitles us to state that in spite of being a difficult and a formidable procedure, total gastrectomy should be performed in certain cases of gastric cancer.

FIG. 1.—Gross specimen of stomach and spleen after total gastrectomy for cancer.

FIG. 2.—Showing stasis and barium retention in the proximal jejunal limb, 24 hours after ingestion of barium, in a patient who had a total gastrectomy without entero-enterostomy between the ascending and descending jejunal limbs.

Which is the future of the patient with a total gastrectomy? It is true that a good percentage of them (I could not give the exact figure) die within the first year following the operation; but it is true also that survivals have been reported; many over two years, a few, as in the case of Moynihan and Mayo, over three years, the patient of Likov, four years, and a few days ago Dr. Cattell told me of having a patient who has surpassed the five-year period. The fact is mentioned that strictures at the gastro-esophageal anastomosis occur very frequently. This is true, since it is present in nearly 40 per cent of our survivals. We feel that this is one of the strongest objections against the procedure. One should watch very carefully the patient for this complication so as to perform dilatations whenever it be necessary. The technic is still to be perfected in this phase

of the problem; maybe the use of vitallium tubes left permanently in place could help to solve the problem. This is a field open to investigation.

CRITERIA FOR TOTAL GASTRECTOMY

According to our judgment, the indications and criteria to select cases fit for total gastrectomy should be as follows:

(1) A neoplastic lesion involving all or the greatest part of the stomach with neither extension to surrounding organs nor distant metastasis. This is the case in linitis plastica or in certain types of sarcoma, and it is exactly in these cases where the best results have been obtained.

(2) Sufficient degree of mobility of both stomach and lower end of esophagus so as to allow the complete removal of the organ and the construction of a perfect jejuno-esophageal anastomosis.

(3) A good general condition of the patient enabling him to stand such a formidable procedure.

(4) All surgeons with some experience in gastric cancer surgery are aware of the fact that a high percentage of patients with a partial gastrectomy develop a recurrence in the gastric stump. The works of Verbruggen about intramural extension of the disease show that it usually goes from three to four centimeters beyond the gross limits of the tumor. Verifications carried on in some of our patients and histologic examination of over 40 operative specimens made by Doctors Mena and Ossandon in the Pathological Laboratory of the Hospital del Salvador, Santiago de Chile, reveal the exactitude of Verbruggen's statements. According to this, and in order that removal be actually radical, the stomach wall should be sectioned three fingers breadth beyond the apparently diseased area. Unfortunately this is not always possible, especially in those cancers that extend along the lesser curvature. New growths confined to the cardia or to the distal end of the esophagus form a group quite apart, since they must be treated by esophagocardiectomy.

(5) Surgical equipment and trained team with experience in gastric cancer surgery.

These patients should be submitted to a scrupulous pre- and postoperative care, the same that should be taken in any serious surgical interference in the abdomen.

The choice of anesthesia is important, since it will be necessary to accomplish a most careful abdominal exploration first to detect any metastatic disease that should be a contraindication to the procedure and then, because if the operation is undertaken, it will always be a long and difficult procedure. We have often used local anesthesia, preceded by a good preoperative analgesia and supplemented with cyclopropane or intravenous injections of sufficient doses of pentothal; spinal anesthesia has proved to be very satisfactory in experienced hands, whether it be the continuous supplemented with pentothal or the Jones' method with nupercaine.

OPERATIVE TECHNIC

The incision we always employ, and that always gave room and exposure enough, is a left paramedian one carried from the costal margin down to one finger breadth below the umbilicus. I am going to refer only to the points that I consider of more importance in the technic of total gastrectomy, disregarding the details. In the first place, and I think that

FIG. 3.—Specimen of a jejunal esophagus removed at autopsy, six months after operation.

The inferior extremity of the esophagus is anastomosed to the jejunum. The scar, product of this anastomosis, is complete. There is no loss of substance at that level. The liver, in the left lobe and on its inferior surface, appears strongly adhered to the anterior surface of the duodenum, with which it forms an oval mass.

The photograph shows both walls of the jejunum separated by a glass tube. Arrow I shows the direction of the esophagus. Arrow II marks the anastomosis of the jejunum with the esophagus. Arrow III shows the jejunum, in which are appreciated its typical folds. Arrow IV shows a piece of the left lobe of the liver adhered to the jejunum.

the agreement is unanimous, the anastomosis should be made with the jejunum rather than with the duodenum: it is of easier execution and is much less dangerous. We begin the procedure by the colo-epiploic separation, followed by clamping and tying of the gastro-epiploic vessels; on

the right side just below the duodenum, on the left side close to the lower edge of spleen; then the gastrosplenic ligament is tied in several small stumps. If this ligament appears to be involved splenectomy should be performed, which, on the other hand, renders the procedure much easier. In two of our nine patients we have had to do it; in one case for uncontrollable bleeding from the hilum; in the other for extensive involvement of the gastrosplenic ligament. Both patients survived, without any disturbance due to the removal of spleen, an experience which I have seen confirmed by several authorities. Then the pyloric artery is identified and tied and the duodenum is cut across, inverting the stump by the usual method, using the Kerr-Parker suture over a Payr's clamp. The coronary vessels are then carefully dissected and tied; the artery should be ligated very close to its origin in the celiac truck. At the end of this stage the stomach is only held by the esophagus.

The next step should be to free the esophagus from its normal attachments to the diaphragm so as to mobilize its lower end down into the abdomen for a length of about five centimeters. To achieve this purpose several manipulations are necessary; if the left lobe of the liver is an obstacle to it, its round ligament should be sectioned, as advised by Grey Turner, and thus freed, so that it may be pushed towards the right, where it will be maintained in place by means of an abdominal retractor. Then the stomach is pulled downwards and the peritoneum is incised at the point where it reflects from the diaphragm to cover the anterior wall of the esophagus, a crescent-shaped flap being thus developed. By careful blunt dissection with the finger or a blunt dissector the esophagus is separated from the diaphragm, thus exposing both vagus nerves which, after previous novocain injection, will be cut; this will allow a further mobilization of the esophagus for about four centimeters more. The stomach is then reflected up and backwards, against the left costal margin so as to expose the posterior wall of the esophagus and perform its anastomosis with the jejunum. The first jejunal loop is then pulled up in front of the transverse colon and is anchored to the diaphragm behind the esophagus by two interrupted fine silk stitches separated one from another about five centimeters, and selecting a loop situated about 30 or 40 centimeters from the Treitz ligament. The anastomosis is performed in two layers; enterior and posterior with interrupted stitches (U-shaped) of fine silk which take support in the muscular layer of the esophagus and the serosa of the jejunum, and through-and-through continuous suture with fine chromic catgut. After these two layers have been placed, the peritoneal flap is sutured covering them with fine silk interrupted stitches.

Roscoe Graham, of Toronto, rotates the afferent loop towards the left and sutures it to the efferent loop in front of the anterior semicircumference of the anastomosis, thus, giving a peritoneal protection to the whole stoma. As he creates in this way a certain obstruction to the afferent loop, he cor-

rects it making a lateral entero-anastomosis between the two loops. It is our belief that it is always wise to perform this entero-anastomosis, regardless of whether Graham's technic is followed or not, as it facilitates the emptying of the jejunum and avoids the distension of the loop, therefore, granting a good relaxation at the level where the sutures are placed. It is advisable to pass a Levin tube through the nostril from the very beginning of the procedure, which shall be passed beyond the anastomosis down to the efferent loop. It gives an excellent rest to the stoma and enables the surgeon to feed the patient during the first eight or ten days. We employed this technic in five of our patients, and that of Graham's in the remaining four. In two of the latter group strictural changes occurred. We believe that while it makes the suturing safer it tends to stenose the anastomosis.

Our personal experience with total gastrectomy is limited to nine cases—eight carcinoma and one sarcoma, which have been operated upon between February, 1940 and May, 1942. During this interval 107 patients suffering from gastric cancer were seen, partial gastrectomy having been performed in 43 and total gastrectomy in nine; in other words, the latter operation was performed in 8.69 per cent of the total of patients and in 16.9 per cent of the gastrectomized ones.

Two of our patients were females. The age distribution was as follows: Twenty-two years, one case; 43 years, one case; from 50 to 58 years, four cases; and from 60 to 65 years, three cases.

The time elapsed between the onset of symptoms and surgical interference was from two months to one year, six cases; of one year, one case; and of two years, two cases.

Involvement of stomach by neoplastic process was as follows: Of the entire stomach, three cases; of the pylorus, one case; of the lesser curvature to the cardia, five cases.

Distribution according to histologic type showed lymphosarcoma, one; linitis plastica, three; gelatinous cancer, one; scirrhous cancer, two; adenocarcinoma, two (one of them with mucous degeneration). The eight cases of cancer showed metastases to the regional lymph nodes. The nodes present a lymphosarcoma, which were very enlarged, showed only catarrhal lymphadenitis.

According to Borrmann's classification, our cases were distributed as follows: Group I, one case; Group II, two cases, Group III, no cases; Group IV, five cases.

Four out of the nine who were operated upon died in the postoperative stage, ranging between several hours and ten days. The cause of death was peritonitis, in two cases (36 hours and six days, respectively); acute anemia (16 hours), one case; and bronchopneumonia in the last case (on the 10th day).

From the five patients who survived the operation, one died from abdominal metastases six months later, one from the same cause seven and

one-half months later, one died of unknown cause during the eleventh month, one died from inanition consecutive to cicatricial stricture of the anastomosis, proved by two repeated biopsies, and who refused to be subjected to further dilatations. Survival of 13 months has been obtained in the other case.

In two of our cases total gastrectomy was not indicated. The first was a 58-year-old woman who developed some gastric discomfort two months prior to the operation. During the operative procedure a pyloric neoplasm was found, with subpyloric metastatic lymph nodes firmly adherent to the pancreas and small enlarged nodes in the pericardial area. These were mostly subserous, and we thought them to be very probably cancerous in nature, both pyloric tumor and stomach were movable, the abdominal esophagus was unusually long, and the patient's general condition quite satisfactory. The removal was an easy one except for the dissection of the nodes adherent to the pancreas, which induced considerable bleeding. The patient died, however, in acute anemia 16 hours after the operation. Due to circumstances beyond our will, transfusion of a proper amount of blood was not administered, which might have spared this patient's life since no hemorrhage and only anemia of all viscera was found on postmortem examination. Histologic examination of the pericardial nodes showed only a catarrhal lymphadenitis; undoubtedly a frozen-section performed during procedure should have changed our whole attitude in this case.

Postmortem examination of the patient who died from bronchopneumonia demonstrated the presence of small metastases in the mesentery of the small intestine, which had passed unnoticed during exploration of abdominal cavity, and whose existence was a contraindication to the total gastrectomy.

We realize that our experience with total gastrectomy is not favorable at all, but this does not mean that we should restrain ourselves from performing it; on the contrary, it stresses the fact that through its employment it is possible to obtain long, lasting cures, provided we improve our knowledge of its precise indications and its operative technic.

PILONIDAL CYST: THE LOCAL USE OF BUFFERED SULFANILAMIDE IN PRIMARY CLOSURE

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IT IS THE PURPOSE of this paper to present an analysis of the immediate results in wound healing of 94 cases of pilonidal cyst in which primary wound closure was attempted. All cases were operated upon by members of the Surgical Service, Station Hospital, Fort Belvoir, Va., between February, 1941, and October, 1942.

The problem of pilonidal cyst is encountered with greater frequency by the Army surgeon than by the civilian physician. In part this is due to the fact that we are dealing entirely with males of the younger age-group, but there is, in addition, the factor of increased physical activity. The patient whose pilonidal cyst has remained "dormant" during his comparably sedentary civil life may find that a short period of rigorous Army physical training, with the attendant perspiration and chafing of clothing at the upper border of the gluteal cleft, has resulted in irritation, producing an inflammatory reaction or an actual abscess. The increased incidence of direct trauma is also important. In this series of 90 white and four colored males the chief symptoms in the order of the greatest frequency were: 1. Pain. 2. Discharge. 3. Itching and skin irritation. 4. Recurrent "boil." 5. Lump. The duration of symptoms varied between one day and 17 years, the average being 21 months. A history of previous flare-up and remission was the rule. But the exacerbation, which in civil life might have been handled by rest and "local applications," and allowed spontaneously to subside, was incompatible with full military duty, and thus the patient was forced to seek early relief. All of these cases were hospitalized with one or more of the above symptoms, and no asymptomatic cysts were admitted for treatment. No cases have been included in this series in which excision was attempted elsewhere, either in a military hospital or in a civilian hospital prior to induction.

In 38 of the 94 cases infection was grossly apparent on admission to the hospital, requiring incision and drainage as the initial procedure. For this purpose we generally employed one per cent novocain local anesthesia, and made a linear incision one to two and one-half inches in length over the fluctuant area. After evacuation of the pus and cleansing of the cavity an iodoform gauze wick was inserted into the cyst cavity and allowed to protrude through the skin edges to prevent sealing of the wound. Cultures

*I wish to express my appreciation to Lieut. F. Louis Knotts, whose critical judgment is as keen as his friendship.

taken at the time of incision revealed the predominant organisms to be *Staphlococcus aureus, Staphlococcus albus, B. subtilis,* diphtheroids and gram-negative bacilli. Beginning on the first or second postoperative day hot sitz baths, two or three times daily for 30 minute intervals, afforded comfort as well as expedited the subsidence of the inflammatory process. These baths were continued, along with various topical antiseptic applications, until such time as excision was deemed advisable, determined by the gross appearance of the lesion, cessation of active drainage, and lowering of the bacterial count. The average time before excision could be undertaken was 14 days.

Fifty-six of the 94 cases did not require incision and drainage for gross infection prior to excision. For these relatively "clean" cases no routine preoperative topical therapy was employed. Some of us believe that injection of the sinus openings with methylene blue solution, done preferably one or two days prior to excision, is of advantage in outlining the diseased tissue areas.

No general agreement prevails in the literature as to the best method for handling the operative wound after removal of the cyst and sinus, and no single procedure has been without drawbacks. Kleckner's[1] report of 4,699 collected cases, of which 4,231 had been done by the open method, seems to indicate that the majority of surgeons would rather be "safe than sorry." In a review of 87 cases, Tendler[2] favored block dissection and open packing with iodoform gauze. He stated that in cases where primary closure was attempted "one out of three (33.3 per cent) broke down or became infected deeply." MacFee,[3] in 34 primary closures, included in his review of 230 cases, reported that 18 (53 per cent) "developed abscesses or other complications which greatly prolonged the healing time." Rogers and Hall[4] used cautery excision followed by open packing of the wound. Smith[5] felt that "complete closure by the Lahey[6] flap method, or any other, if successful, gives the shortest convalescence. Owing to the prolonged healing time in the wound in which infection flares up, however, the average of the group is not better than by other methods." Cutler and Zollinger[7] opened the sinus tracts and applied a sclerosing solution. Colp[8] anchored the wound flaps to the fascia over the sacrum and coccyx, and in MacFee's[3] modification the skin itself is sutured directly to the fascia near the midline. Other forms of partial closure, undermining of flaps for better obliteration of dead space, retention sutures, and various other technics have been employed by others. Over the head of the surgeon who favors primary closure has continued to hang the scimiter of wound infection and recurrence, in spite of good results by this method, as reported by Ferguson and Mecray,[9] and Gage.[10]

In this hospital we eliminated the open packing method following excision for the following reasons:

1. Prolonged hospitalization is necessary, with consequent longer absence from military duty.

2. The resulting wider, tender, thinly-epithelized scar is a discomfort to the soldier who is required to ride the hard seat of a jeep or truck, or who must assume a sitting posture with alacrity on the rifle range, and we have seen disability result from such scars split open under such stress.

3. We believe that this method is a makeshift, more useful in eliminating feared postoperative sequelae than in dealing with the primary condition.

Wound flap technics may be criticized on the basis of:

1. Prolonged hospitalization, undesirable from a military point of view.

2. Realignment of tissues at variance with their normal anatomical positions—as in the skin-to-fascia suture.

3. Deprivation of the sacrococcygeal fascia of its protective buttress of fat.

It is generally agreed that primary closure would represent the method of choice were it not for the risk of wound infection and recurrence. Statistics covering recurrence are extremely variable, so variable, in fact, that Rogers[11] suggestion that many so-called "recurrences" represent infected dead spaces resulting from faulty healing is not to be lightly discarded.

The technic of excision and closure we employ is as follows:

1. Under spinal procaine (100–150 mg.) or intravenous sodium pentothal anesthesia, an elliptical incision is made to encompass the entire cyst and sinus areas, but excising no more of the surrounding tissues than necessary to insure complete removal of the diseased parts. By careful dissection a minimal amount of normal skin and subcutaneous tissue is sacrificed, and, in this sense, we do not employ a true block dissection. Lateral ramifications of sinuses are dissected out in such a manner that the wound edges are not widely separated, spur incisions at right angles to the main vertical incision being made when necessary for this purpose. A wider-than-necessary cutting of the skin and subcutaneous tissues only makes closure of the wound more difficult and obliteration of the dead space more impractical. The small No. 15 Bard-Parker scalpel blade is an advantage in careful dissection, and traction on the lower or upper border of the elliptical skin edge to be excised aids in establishing a line of cleavage.

2. After removal of the diseased tissue, larger vessels are ligated with No. 00 plain catgut. Ooze is controlled by hot saline sponges. A dry wound is essential.

3. Careful inspection of the removed specimens and of the wound borders, especially the skin edges, aids in insuring that no diseased tissue remains. The greyish appearance and firm, gritty feel of a residual portion of a sinus tract or cyst wall can usually be recognized and the border of the incision extended to encompass it if present.

4. Interrupted sutures of No. 0 or No. 1 chromic catgut are placed to approximate the deep layer, the bites being taken into the lateral walls of the cavity beginning about one-half to three-quarters of an inch below the skin edge, and are anchored to the presacral fascia. These are spaced about three-fourths of an inch apart, and in such manner that each repre-

sents a simple suture, the entire circumference of which, if possible, is buried in the tissues except at the top where the knot is to be tied. We do not feel that undercutting of the fat is necessary or advantageous, since it increases bleeding, and may further reduce a none-too-adequate vascular network.

5. A sulfonamide drug preparation is sprinkled into all portions of the wound cavity. One-half to one and one-half grams of the powder is sufficient, depending upon the extent of the incision. Overuse may give rise to caking at the bottom of the wound, and may interfere with tissue healing by foreign body action, as suggested by Bick.[12]

6. The buried catgut sutures are then knotted, and they lie, at their uppermost points, about one-half to three-fourths of an inch beneath the skin margins. Placing them relatively close together aids in uniform obliteration of deep dead space, and minimal tissue excision insures that they will be tied under the least tension possible. Such buried sutures were used in 82 of this series of cases. In the remaining 12 cases the simultaneous approximation of deep and superficial tissues in one layer was attempted by the use of silk, silkworm gut or steel wire. We do not feel that such retention sutures passed through all layers, and either tied on the surface or over a gauze roll, secures as good approximation of the deep tissues, and that likelihood of introduction of infected material into the wound at the time of suture removal is greater.

7. Closure of the superficial subcutaneous tissues and skin edges is accomplished with interrupted No. 0 or No. 1 silk vertical mattress sutures (35 cases), subcuticular silk suture (13 cases), subcuticular steel alloy wire suture (15 cases), and interrupted steel alloy wire sutures (17 cases), or other suture material as dictated by the operator's preference. Absolute evenness in approximation of skin margins is important because of the proximity of the rectum and the attendant possibility of contamination from this source.

8. Sprinkling or dusting the suture line of the closed wound with a sulfonamide preparation may be an additional safeguard against surface bacteria as well as an aid in keeping the incision dry.

Postoperative attempts to obliterate potential or actual dead spaces by means of gauze rolls, pressure dressings, and placing the patient on his back may be harmful in that local circulation is interfered with. Such obliteration is better accomplished at the time of operation by the deep suture layer in the vertical plane. Consequently, we prefer a dry gauze dressing secured not too tightly by adhesive strips. This dressing is changed on the second or third postoperative day, and during the intervening time a bowel movement should not be encouraged. Purges and enemata should be avoided.

The topical application of sulfonamides to wounds, both traumatic and operative, with a view towards prevention of infection or of combating infection already present, is under thorough discussion at the moment.

The understanding of the mode of action of sulfonamides has recently made considerable progress, particularly since it was shown by Schmelkes, Wyss and associates[13] that the anion of the sulfonamides is the agent that contributes mostly to the antibacterial effectiveness of sulfonamide solutions and that the difference between various sulfonamides is based upon the degree of their acidic dissociation. These workers drew the logical consequence from their experiments of postulating that as the p_H of the environment is increased the relative effectiveness of the stronger acids in comparison with the weaker acids would be progressively obliterated, and that actually at p_H 9 there is a very little difference mg. for mg. per cent between sulfathiazole and sulfanilamide. In view of the very much larger solubility of sulfanilamide, implantation of sulfanilamide crystals in an environment at p_H 9 should result in much more effective local chemotherapy than any other of the conventional sulfonamides.

We, therefore, obtained* a preparation of buffered sulfanilamide powder which contained ten per cent calcium carbonate in addition to the conventional crystalline sulfanilamide now in use. Calcium carbonate was used rather than soluble buffers because it was believed that in this manner buffering of the environment could be brought about that would last as long as the sulfonamide effect itself.

The following is a preliminary report of a comparative investigation of the implantation of this buffered sulfanilamide into a series of postoperate wounds obtained by the excision of pilonidal cysts:

TABLE I

Number of Cases	Drug Employed	Primary Healing	Infected Wounds	Average Number of Days in Hospital After Excision
29	0.5-1.5 Gm. None (controls)	21 cases 72%	8 cases 27%	24.8
5	Sulfathiazole	5 cases 100%	None	22
32	Sulfanilamide	22 cases 69%	10 cases 31%	27.9
28	Buffered sulfanilamide	27 cases 96.4%	1 case 3.6%	18.8

Comment: Our criteria for classification of wounds as clean or infected was, of necessity, largely clinical rather than bacteriologic, since the presence of an abnormal number of surface organisms in this area of the body alters the validity of wound smears. Elevation of the patient's temperature, with the findings of increasing local tenderness, redness, and the spontaneous discharge or mechanical release of murky fluid or frank pus from the incision were considered significant.

* Through the courtesy of the Research Laboratories of Wallace & Tiernan Products, Inc., Belleville, N. J.

Sulfathiazole was used in only five cases because we were unable to secure an adequate supply of the drug in powdered form. The five cases are not considered to be of statistical value.

The cases in which buffered sulfanilamide was used showed a remarkably high incidence of primary healing without infection. This result can not be accounted for in any manner except by the action of the drug itself, since no other major variable in technic occurred. The percentages of each large group (Table I) requiring incision and drainage prior to excision were proportionately constant:

No drug (controls)	11 cases (38%)
Sulfanilamide	14 cases (43.7%)
Buffered sulfanilamide	12 cases (42.8%)

No systemic sulfonamide was administered except after gross infection was apparent and drainage and wound irrigations instituted. Therefore, these wounds, as far as this tabulation is concerned, may be considered to represent the local sulfonamide action only.

TABLE II

Drug Employed 0.5-1.5 Gm.	Wound Serum	Percentage of Primary Healing Groups (Table I)
None (controls)	9 cases	31. %
Sulfanilamide	6 cases	27.2%
Buffered sulfanilamide	7 cases	25. %

In Table II are shown, under their respective groups, those wounds which healed by primary union but in which serum formation, without clinical evidence of wound infection, was detected. The percentages are comparable, and from this limited evidence we can make no deduction that either plain sulfanilamide or buffered sulfanilamide, in the quantities used, has a definite irritative foreign body action.

However, the presence of serum in clinically detectable amounts did delay healing, as can be seen when all cases are subdivided on the basis of wound status (Table III).

TABLE III

AVERAGE NUMBER OF DAYS IN HOSPITAL—94 Cases

Primary Healing Without Serum	Serum	Infection
17.9	26	40.5

It is to be remembered that when released from the hospital these cases were discharged to duty. All wounds were clinically healed at such time, although residual sensitivity of the scar to palpation and pressure was still present in most instances. We regret that the follow-up period of observation is necessarily short, and we, therefore, have no data on the question of recurrence.

Finally, the general similarity of these wounds and their anatomic location in a region of the body where wound infection is a common occurrence makes this study of the bacteriostatic effect of these drugs of some value.

SUMMARY AND CONCLUSIONS

1. Immediate results in a series of 94 cases of excision of pilonidal cyst, with primary wound closure, have been presented from the standpoint of operative technic and wound healing. We believe primary closure to be the method of choice from a military point of view.

2. The use of buffered sulfanilamide powder dusted into the wound at the time of operation has markedly reduced the percentage of postoperative wound infections, which effect plain sulfanilamide alone failed to produce.

3. The local use of buffered sulfanilamide in traumatic war wounds may be suggested from the standpoint of availability, economy and efficiency.

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BILIARY DYSKINESIA FROM THE SURGICAL VIEWPOINT

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THE CLINIC

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FUNCTIONAL CHANGES causing disease are in general poorly understood and frequently go undetected because of the lack of demonstrable pathologic changes at the operating table and in postmortem examinations. Dyskinesia or disorders in the motility of the extrahepatic biliary passages is an outstanding example.

Few surgeons, of wide experience in gallbladder surgery, have escaped disappointing results following cholecystectomy. This may be the case even when there is definite evidence of cholecystitis, with or without cholelithiasis. It is more particularly so when, at operation, no definite pathologic condition is found, and the gallbladder is removed because the history suggests trouble or the gallbladder visualization test suggested that the organ was not functioning properly. After the abdomen is opened it is extremely difficult, at times, to weigh all the evidence accurately that has been accumulated preoperatively with that obtained by visual and manual examination, in determining whether or not to remove the gallbladder or explore the bile ducts. I can recall being unable to detect small stones in a normal looking gallbladder by palpation even after all the bile had been aspirated, and their presence was only demonstrated after the gallbladder was widely opened. At another time the gallbladder was removed without gross evidence of disease because of the characteristic history and because there was a small, questionable filling defect in the visualized gallbladder. On opening the removed organ a very small pedunculated adenoma was found that had undoubtedly intermittently obstructed the cystic duct. Removing the gallbladder relieved the patient of her symptoms. If doubt exists at times as to the advisability of removing the gallbladder how much more frequently the question arises as to the advisability of exploring the common duct. After the duct is opened one can never be sure that all the stones have been removed, even since the use of visualization of the biliary ducts by opaque media during the course of the operation. If symptoms of biliary colic recur following operation, doubt usually still exists as to whether or not symptoms are due to a stone having been overlooked, as to whether or not one is dealing with a functional type of biliary passage involvement, or whether or not some other organ or structure is at the bottom of the trouble.

We are familiar with the teachings of Lahey and with his insistance on exploring many more common ducts than have been explored in the past. This, in the hands of men qualified to do this type of surgery, has undoubtedly resulted in fewer instances of postoperative disappointment. It

has not, however, solved all of the problems that arise in this field of surgery.

That symptoms of gallbladder colic can occur and no stones can be demonstrated at operation, either in the extrahepatic biliary ducts or in the gallbladder, is a fact well known, and considerably written about. The first individual apparently to call attention to this was Krukenberg,[1] in 1903, and Borghi,[2] in 1913. In 1909, the pathologists Aschoff and Bacmeister[3] contributed further to the subject by describing the "stasis gallbladder occurring without inflammation or stones." Schmieden,[4] in 1920, wrote of the individual with gallbladder distress in whom at operation no stone or inflammation could be found and yet who showed a markedly distended gallbladder. He attributed these symptoms and findings to an anatomic defect involving the cystic duct. Berg,[5] in 1922, suggested that biliary stasis might be the result of a functional disorder of the sphincter muscle of the ampulla of Vater, because he was able to demonstrate hypertrophy of this muscle in an individual with biliary symptoms and no other findings. Numerous investigators have interested themselves in the question of functional disorders of the biliary system. The concept that biliary distress and pain may result from motor dysfunction of the extrahepatic ducts presupposes that spasm of the sphincter mechanism about the ampulla of Vater, or perhaps elsewhere along the ducts, raises the intraductal pressure to the point where pain is produced. Distention of organs causes pain. Severe and excruciating pain occurs in Dietl's crisis when the pelvis of the kidney is suddenly distended; plugging of the cystic and common duct by stone results in severe colicky pain; distention of the intestine following obstruction gives similar symptoms. That the sphincter muscle about the ampulla of Vater is capable of resisting high intraductal pressure has been demonstrated experimentally and was strikingly evident in one of the cases which will be cited later.

Ivy[6] has shown experimentally in dogs that the gallbladder may contract with a maximum of force of about 30 cm. of bile pressure, which is also about the secretory pressure of bile, whereas the common duct sphincter may contract and exert a resistance of as much as 80 cm. of bile pressure. Thus, it is evident in the dog, at least, that a spastic choledochoduodenal sphincter mechanism may cause an intrabiliary passage pressure sufficient to block the flow of bile either from the gallbladder or liver. Further evidence was elicited by Ivy, and his coworkers,[7] in humans, which permitted them to conclude that "pain may be elicited from noninflamed biliary passages by the maximum pressure that may occur in their lumen provided the pressure is raised rather rapidly, especially in the presence of a tonic musculature."

To further quote Ivy, and coworkers: "This concept also provides a rational basis for gallstone colic without gallstones, for so-called 'cholecystitis,' with a normal gallbladder at operation, and for so-called 'hepatic neuralgia.' It is further possible that the presence of an irritable or hype-

trophied sphincter of the common duct may explain the recurrence of symptoms in some patients following cholecystectomy. The early relief would be due to the temporary paralysis of the sphincter that always follows cholecystectomy. But, after recovery from the temporary paralysis, the irritable or hypertrophic sphincter may again produce symptoms of biliary tract distention. The recognition of this possibility should emphasize the importance of the medical rather than the surgical management of these patients, although it must be recognized that some dyskinesia patients are benefited by cholecystectomy and some patients with residue after cholecystectomy are benefited by choledochoduodenostomy. In this connection, Aschoff[3] reports a series of 215 cases in which 25 stone-free gallbladders were removed; of the 25, seven had residual symptoms accountable for only by dyskinetic processes. It is likely that the number of discouraging results may be fewer when the idea of a functional disturbance is better understood and managed therapeutically by the surgeon and internist. We would state, however, that we do not believe the diagnosis of dyskinesia to be simple. The presence of pain in the gallbladder region with a normal 14-hour cholecystogram, and absence of clinical evidence of an inflammatory process, may lead one to suspect but not diagnose a dyskinesia. In this communication we have desired only to emphasize that the possibility of the occurrence of biliary dyskinesia should be borne in mind and requires consideration in the etiologic analysis, diagnosis and therapy of biliary tract diseases."

McGowan, and coworkers,[8] in 1936, interested themselves in the direct measurement of changes in physiologic function of the common bile ducts of human beings who had disease of the biliary tract. Apparently, they were the first to carry on such investigations in the human being. Individuals into whose common duct T-tubes had been placed for prolonged biliary drainage were used for their investigations; eight individuals were used and 15 observations were made. They found that giving ⅙ gr. morphine subcutaneously produced an increase in intraductal pressure on 14 occasions, pressure began to rise from two and one-half to four minutes after the injection, and reached a plateau in from 10 to 15 minutes. Rise in pressure was associated with constant pain in one case. The pain was situated in the right upper abdominal quadrant and extended around the right subcostal region and to beneath the right scapula. Five attacks of pain occurred during the course of study, and in each instance was associated with a rise in intraductal pressure. The duration and severity of the pain corresponded in each case with the height of the pressure curve. On one occasion the pressure was as high as 160 mm. of water. This was the same type of pain from which the patient had suffered since removal of her gallbladder one year previously.

From their studies, the effects of morphine on the biliary system made this evidence available: "(1) Fluid can be made to flow from the common

bile duct into the duodenum after administration of morphine only by increasing the pressure. In other words, the perfusion pressure is increased. (2) Roentgenograms made before administration of morphine give evidence of rapid emptying of the common duct; the opaque medium usually is found in the duodenum. Roentgenograms of the same patients after administration of morphine give evidence of distention of the common duct. Opaque substances remain in the hepatic ducts and smaller branches of the biliary tree and the lower end of the common duct tapers to a sharp point, suggesting muscular spasm; the picture is not unlike that of the esophagus in the presence of cardiospasm. The drug that produced complete disappearance of pressure and absolute relief of pain was amyl nitrite. A few whiffs of this drug, almost at once, brought the pressure down to zero, where it remained for a few minutes and slowly returned, after about 15 minutes, to the level at which it had been after administration of the morphine. At the same time that the pressure fell, the patient was completely relieved of pain."

Strauss,[9] and associates, in 1933, reported 29 cases of chronic biliary stasis without stones, which they believed were due to a triangular infection of the duodenum, pancreas and common duct. They thought the infection probably began as a duodenitis and ascended the common duct producing infiltration and swelling of the ampulla of Vater and lower part of the common duct, thereby causing spasm and obstruction of the papillary outlet of varying intensity. In some of these cases attacks simulating gallstone colic were produced, and in others jaundice simulating that caused by obstruction of the common duct from carcinoma of the head of the pancreas. Satisfactory results in most instances followed choledochoduodenostomy plus gastro-enterostomy. Undoubtedly, most of these cases could be classified in the category most frequently spoken of as dyskinesia of the biliary passages.

From this citation of the evidence accumulated by the above investigators and clinicians, it is evident that a typical picture of gallstone colic can be produced when no stones are present, either in the gallbladder or biliary ducts. Those are the cases in which the surgeon at the time of operation may be very much in doubt as to what course to pursue. His decision usually takes one of three directions: (1) He removes the gallbladder—perhaps explores the common duct. (2) He decides that a mistake in the diagnosis has been made, looks around for something else to account for the symptoms and, generally, winds up by taking out the appendix—meanwhile, offering up a prayer to the effect that he hopes the trouble has been found and eradicated. (3) He closes the incision and admits defeat.

Whatever the course taken, it is surprising how many people remain free of further symptoms. An indefinite percentage of the cases continue to complain of symptoms the same as previous to celiotomy, and are generally then classified as being neurotic. Again, it may happen that sufficient trouble is found at operation, usually cholecystitis with cholelithiasis, even

stones in the common duct, to account for the patient's symptoms, and yet after proper correction the symptoms persist. The conclusion usually reached, and the condition usually found, if the patient is reoperated upon, is that a stone was left or had reformed in the common duct.

Such an example stands out vividly in my memory, even though it occurred a number of years ago. A woman with typical gallstone colic was operated upon. The gallbladder, containing numerous stones, was removed, the common duct was opened and numerous stones were removed from it. None remained, so far as could be ascertained. Shortly after discharge from the hospital the patient experienced severe abdominal pain suggestive of gallstone colic. Attacks recurred with increasing severity but the patient steadfastly refused further operative interferences and died suddenly in the height of a paroxysm of pain. Autopsy revealed a small stone, a few millimeters in diameter, in the ampulla of Vater.

Such a train of events may take place, however, and no stones or other pathologic condition be found to account for the symptoms. It is in such a case that one must bear in mind the possibility of a functional abnormality —so-called dyskinesia of the biliary passages. The two following case reports are illustrative, in my opinion, of such a condition:

Case 1.—Mrs. A., Queen's Hospital No. 152069, first came under my care, November 24, 1928, because of pain in the region of the gallbladder, suggesting gallbladder colic. She stated that for the past 15 to 20 years she had suffered intermittently from such attacks of pain. There had never been fever, chills or jaundice, in spite of recurrent severe attacks of pain requiring morphine for relief. She did not submit to operation until July 23, 1932. The gallbladder contained one large stone, several smaller ones, and débris. The common duct was palpated but not explored. The gallbladder was removed. Twelve days after operation the same type of abdominal pain recurred, requiring morphine gr. ½ for relief. These attacks occurred repeatedly until she was operated upon for the second time on May 21, 1935. It was our conclusion that a stone in the common duct had been overlooked. At operation, the common duct was found to be somewhat larger than normal, but not markedly so. The extrahepatic ducts were thoroughly explored including probing, scooping and irrigating, and no stone could be found. A rubber ureteral bougie could be passed well down into the duodenum and, after freeing the descending duodenum and rotating it to the left, the common duct in its entirety could be palpated, but nothing abnormal could be detected. We were, again, much chagrined but equally in doubt as to the cause of our patient's disability. Symptoms were relieved for a while but soon recurred the same as before.

These attacks were unrelieved by amyl nitrite or nitroglycerin. She at no time developed clinical jaundice though the icterus index was 25 on November 10, 1939, and on May 9, 1940, it was 11 and the van den Bergh 3.25 mg. per 1,000 cc. All types of examinations were made, including gastro-intestinal, urinary, blood tests for lues, *etc.*, to explain the attacks of pain, but were all negative. The pain was so typical of biliary trouble—epigastric and right upper quadrant, radiating to back, and of such increasing severity, we felt justified in again exploring the common duct. This was done February 9, 1942. Needless to say, the procedure was difficult because of many adhesions from the two previous operations. The common duct, which was somewhat larger than normal, was again opened and explored, as well as the hepatic ducts, and

no stones could be found. A rubber ureteral bougie, similar to the one which had been passed into the duodenum at the previous operation, could not be made to pass the ampulla of Vater, and neither would saline injected into the duct. In order not to overlook a stone that might be lodged in the distal end of the duct, transduodenal exploration of the ampulla of Vater was decided upon. The descending part of the duodenum was freed along its lateral side, allowing mobilization of this part of the intestine. A longitudinal incision was made in the anterior wall of the duodenum over the region of the opening of the common duct (Fig. 1a). Though the interior of the duodenum contained a considerable quantity of bile, the opening of the duct could not be located. Saline was then injected into the common duct above by inserting

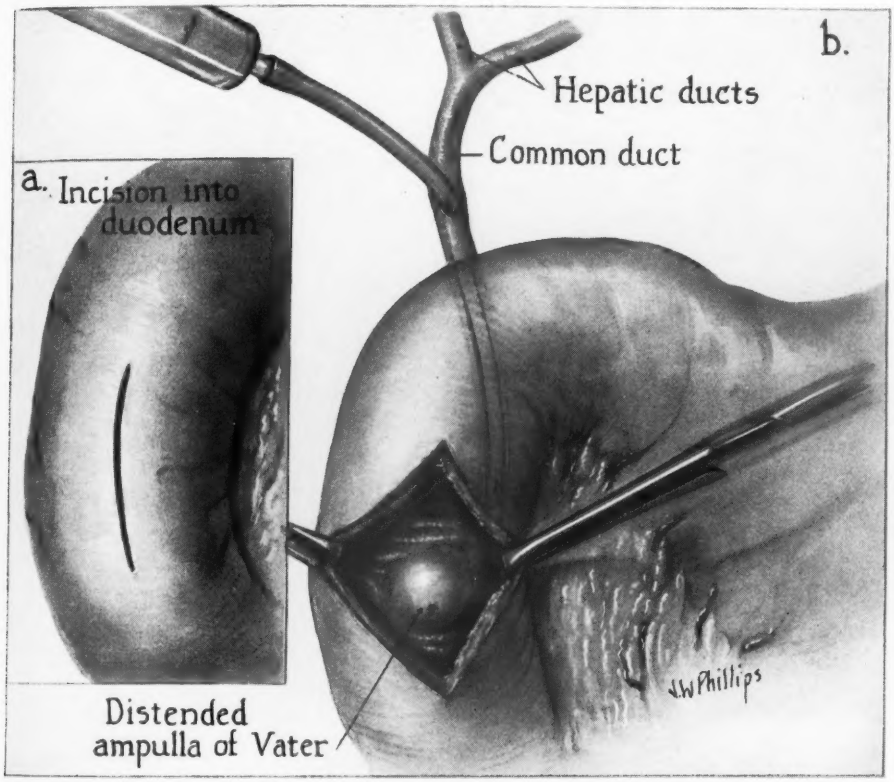

FIG. 1.—A. Shows site of incision in the duodenum to expose the opening of the common duct. B. Showing site of insertion of catheter to irrigate the common duct.

a catheter, as shown in Figure 1b, and though the region of the ampulla of Vater blew up like a balloon not a drop of saline escaped. Repeated efforts brought the same results. Since the patient had never been clinically jaundiced and there was bile present in the duodenum, it was concluded that we were dealing with a spasm (dyskinesia) of the sphincter of Oddi.

An incision was made, approximately one-half inch in length, into the ballooned-out area (Fig. 2c), and this gave a free opening into the lower end of the common duct. So far as I could determine there did not appear to be an unusual amount of hypertrophy of the sphincter muscle. However, lack of familiarity with the thickness of the normal sphincter, plus difficulty of getting a clear view because of blood and bile, made this observation of doubtful value. The common duct was now easily irrigated out, probed and scooped, and no evidence of stone could be found. The opening into the

ampulla of Vater was held open by interrupted fine chromic catgut sutures (Fig. 2d). The opening in the duodenum was sewn transversely, using a row of chromic catgut and an outer row of silk; the line of suture being covered over with a patch of omentum (Fig. 2e). The opening in the common duct was closed tight with interrupted chromic sutures. One rubber tissue drain was inserted into Morison's pouch and the incision was closed in layers. The patient made an uneventful recovery and to date (October 1, 1942) has been entirely free of gallbladder symptoms.

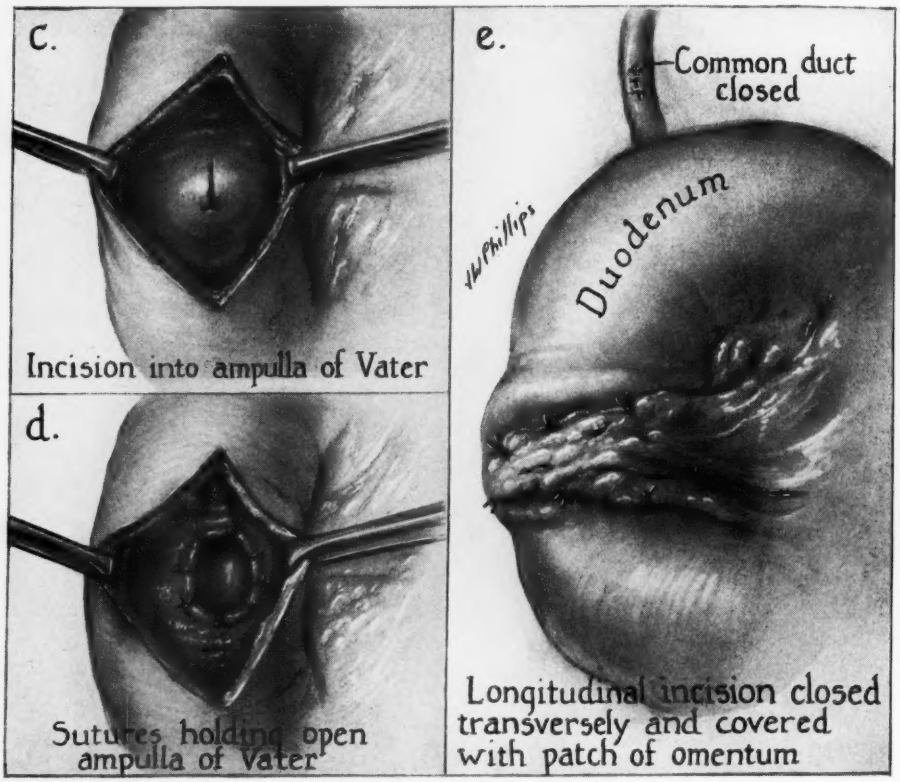

FIG. 2.—C. Showing the incision into the ampulla of Vater. D. Showing the technic of procedure of holding open the ampulla of Vater. E. Showing the method of protection of the incision into the duodenum.

Case 2.—A female, age 48, had had, for the past 20 years, recurrent severe attacks of epigastric pain. After the December 7, 1941, "blitz" these attacks became much more frequent and more severe. Roentgenologic examination following gallbladder visualization substantiated the diagnosis of gallbladder disease. At operation, June 1, 1942, a gallbladder containing numerous stones was removed. The common duct was explored by palpation only, since neither the history nor local findings suggested common duct stones. The second day following operation the patient stated that the same pain recurred, though it may have been that she could not differentiate this from postoperative distress. At least, very soon following operation she developed excruciating attacks of pain similar, but even more severe, than previous to operation. These attacks required repeated injections of large amounts of morphine for their relief. At no time was clinical jaundice evident. Because stone in the common duct is the most frequent cause of such symptoms, it was felt that we were probably dealing with this condition,

though dyskinesia of the sphincter of Oddi was considered largely because of our recent experience.

Exploration of the common duct was undertaken, June 2, 1942, with practically the same findings as in Case 1. The duct was not noticably enlarged. No stones could be found. Fluid could not be made to pass into the duodenum when injected into the common duct. A soft lead probe was gently passed down the duct as far as possible in order to help identify the proper place to open the duodenum in our search for the ampulla of Vater. The ampulla was not readily identified, but with a finger in the duodenum, as a guide, the probe was gradually worked through the common duct opening. Rubber catheters of increasing size were attached to the probe, and to one another, and drawn back up the common duct. No stones were extracted and none could be washed out by irrigation. An incision was made through the ampulla to include the sphincter of Oddi which, again, did not seem unduly hypertrophied. No sutures were placed in this incision. The duodenal incision, the opening into common duct, and abdominal wall were closed as described in Case 1. The patient made a good recovery. She left the hospital on the twelfth postoperative day, and has been symptom-free to date, October 1, 1942, of all symptoms suggesting biliary colic.

In the treatment of biliary dyskinesia and other conditions attributed to an abnormality in the region of the ampulla of Vater, in which no organic lesions were demonstrable, various surgical means of correction have been advised. Removal of the gallbladder with prolonged drainage of the common duct by means of a T-tube has its advocates. Dilating the ampulla of Vater by using sounds of increasing size has been done, apparently, with success but not without unfortunate and even fatal results, due to injury of the duct, followed by retroperitoneal infection. Strauss,[9] in the cases previously referred to, preferred choledochoduodenostomy followed by gastro-enterostomy was added to the primary operation to side-track the stream of food and lessen intraduodenal pressure, in order to minimize the danger of food regurgitating up the biliary passages. It would seem to me controversial whether the danger from a gastrojejunal ulcer developing following gastro-enterostomy might not outweigh the dangers from bile regurgitating up the biliary passages.

Colp and Doubilet[10] have found that physiologic disturbances of the sphincter of Oddi bear an important relationship to certain types of acute pancreatitis, gallbladder disease, the post cholecystectomy syndrome, the dyskinesia of the biliary tract, and some forms of transient jaundice. To cerrect the spasm of the sphincter of Oddi they have devised an instrument (sphinctertome) which they pass down the common duct into the duodenum. It is then withdrawn until it contacts the intestinal wall. A piece is then bitten out which is supposed to include a portion of the sphincter muscle. The procedure corresponds to the blind-punch operation for prostatic hypertrophy, which preceded our present methods of visual precision. While the method worked satisfactorily in the hands of the inventors it would seem to be fraught with considerable danger due to the blindness of the maneuver.

Anastomosing the gallbladder to the stomach or duodenum may be done, and is the procedure usually carried out in the presence of jaundice thought

to be due to malignancy of the head of the pancreas. Usually the gallbladder has been removed before it becomes apparent that one is dealing with a physiologic disturbance of the sphincter of Oddi. In fact, it is a diagnosis arrived at largely by the process of exclusion.

The operation of transduodenal exploration of the ampulla of Vater and subsequent division of the sphincter of Oddi, the method employed in our two cases, is the only procedure that lends itself to arriving at a correct diagnosis. It permits of a direct visual attack on the seat of trouble and if a stone is present this can be removed and unnecessary and undesirable side-tracking operations prevented. It is not an operation to be considered lightly, for it has potential possibilities of serious complications. However, with due amount of care and caution the risks can be kept at a minimum.

SUMMARY AND CONCLUSIONS

1. Symptoms of biliary colic can and do occur in the absence of gallstones. Biliary dyskinesia must be thought of when no stones are found at exploration.

2. Dyskinesia of the biliary passage is a disease entity with which the medical profession needs to become more familiar.

Two cases of this condition are cited, with the method employed in their correction, and a short discussion of the subject in general is indulged in.

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THE ADMINISTRATION OF MORPHINE AND ANTISPASMODICS IN BILIARY COLIC

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Biliary colic not infrequently presents a problem which the physician or surgeon is unable to solve immediately and satisfactorily by various hypodermic measures. Inquiries among colleagues will show that it is quite customary to administer ¼ or ½ grain of morphine for biliary colic, and if relief does not follow within 30 minutes or more, to give a second hypodermic of the morphine together with $\frac{1}{100}$ or $\frac{1}{150}$ grain of atropine. The latter will often afford relief after morphine alone has failed. This is apparently the popular method of administering hypodermics for biliary colic whether the gallbladder is present or has been removed.

One of us, (R. R. B.[3, 4]) reported, in 1936, on the use of nitroglycerin in spastic biliary dyssynergia and with cholangiograms demonstrated the relaxing effect of nitroglycerin on the choledochal sphincter area in some cases. Butsch, McGowan and Walters[6] reporting, in the same year, on the effects of various drugs on the choledochal sphincter area, emphasized the more immediate relaxing effect of amyl nitrite and the more lasting effect of nitroglycerin. From further experimental studies and clinical experience with morphine and antispasmodic drugs, we believe we are now able to draw more practical conclusions regarding the management of the various types of biliary colic, namely, spasm of the gallbladder, the cystic duct or the choledochal sphincter.

Since the original experiments of Kitakoji,[13] in 1930, which were later confirmed by Lueth,[16] and others, as well as by our own observations, it has been accepted that morphine and allied drugs increase the resistance of the sphincter at the lower end of the common duct. If the flow of bile is blocked by stones in the common duct, intraductal pressure rises, and in turn causes pain. Also morphine would continue to give the effect of increasing pain by contracting the sphincter mechanism, except for the fact that it tends to blot out the sensation of pain in the cerebral centers. It has been my observation among patients with severe biliary colic that many notice a sharp increase of pain for a few minutes after a hypodermic of morphine is given, but relief often follows as soon as the morphine acts on the higher nerve centers. Frequently, a second hypodermic of morphine, or morphine with atropine, is necessary before satisfactory relief is obtained. The second injection of morphine further depresses the higher nerve centers while still maintaining the spasm of the sphincter area at the lower end of the common duct, thus giving relief from pain without physiologic release

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of the increased pressure in the biliary system. An antispasmodic which would be used in conjunction with morphine to consistently relax the musculature of the gallbladder, the cystic duct or the sphincter area at the lower end of the common duct, would be an efficient and reliable means of affording physiologic relief for patients with biliary colic. Experimental studies by a number of investigators have revealed no drug which is a consistent, true biliary antispasmodic in the sense of relaxing these three structures.

As for drugs which will effect relaxation of the gallbladder wall, many workers (Ivy and Bergh,[10] Ivy and Oldbergh,[11] Johnston and Brown,[12] Lieb and McWhorter,[15] and Lueth, Ivy and Kloster[17]) believe from their experiments and experience that atropine is effective. In a recent article, Kozoll and Necheles[14] stated they could not confirm the relaxing effect of atropine with small amounts, but they did see a decreased tonus rhythm. The musculature of the cystic duct probably relaxes with the gallbladder musculature. Trasentin seems to have a relaxing effect on the gallbladder similar to that of atropine. Lieb and McWhorter, in 1915, came to the conclusion that the nitrites relaxed the isolated gallbladder musculature. They felt that morphine had no significant effect upon this structure, and the same opinion is held by other authors.

In analyzing the sphincter mechanism of the lower end of the common duct, we must consider a group of separate circular fibers and also the duodenal musculature. Schwegler and Boyden,[18] after describing the components of the sphincter of Oddi in great detail, state that its most important segment is a sheath of annular fibers enclosing the preampullary portion of the bile duct and that the muscle is so well developed and strategically placed as to be capable of stopping the flow of bile into the duodenum independently of the intestinal muscle. Any drug such as morphine, by producing increased tone of the duodenal musculature through which the lower end of the common duct transverses, may, in itself, be capable of blocking the lower end of the common duct, thus giving rise to increased intraductal pressure and pain. However, Boyden and Bergh, after anatomic studies of the musculature of the lower end of the common duct and duodenum, state that they would not expect the duodenal portion to play an important part in regulating the flow of bile in man. If this is true, one must deduce that morphine acts directly on the choleductal muscle fibers similarly to its action on the duodenal musculature. If this is true, then we must also consider the effect of the antispasmodics in the same light. Again, we must not lose sight of the possibility of some coordinating mechanism between these two muscular groups.

Since, at present, we have no completely satisfactory antispasmodic for the biliary tract as a whole, the drugs which are now used should be properly applied. Atropine, the most commonly used antispasmodic, does not in itself consistently relax all biliary musculature and relieve pain. By its paralyzing action on the parasympathetic nerve endings, the sympathetics (splanchnics)

which serve to relax the gallbladder are brought into play, but possibly by the law of contrary innervation, atropine may serve to contract the sphincter mechanism. It is believed that stimulation of the parasympathetics results in contraction of the gallbladder and relaxation of the sphincter. Ivy[9] believed from his observations that atropine relaxed the sphincter mechanism in man. In 1938, one of us (R. R. B.[4]) reported that atropine did at times have a relaxing effect on the choledochal sphincter as far as symptoms and cholangiographic studies could be interpreted. Bergh[1] reported, in 1941, that atropine had no consistent effect on the choledochal sphincter mechanism in ten patients. This statement certainly corroborates our experience. In other words, there is evidence of choledochal sphincter relaxation by atropine in some cases, while in others there appears to be no relaxing effect.

The phrase "a relaxing agent" may not be exact terminology as a drug which would only raise the irritability threshold might result in an effect consistent with the assumption that the muscular fibers were not as contracted or spastic as before administration of the drug. Doubilet and Colp,[8] following a group of interesting experiments, are definitely of the opinion that atropine does diminish the irritability of the common duct sphincter, although the resistance of the sphincter remains within the normal range. These experiments also prove quite conclusively that when hydrochloric acid reaches the duodenum in man, it increases the muscle tone of the sphincter of Oddi. This may be a factor in the inconsistency of the reports on the action of drugs in biliary tract conditions. It is interesting to note how frequently patients suffering from biliary tract disease state that sodium bicarbonate temporarily relieves milder attacks of biliary discomfort. This probably can be explained on the basis of neutralization of the acids in stomach contents before they reach the duodenum. A high acid level in the duodenum doubtless would interfere with the effect of the relaxing agent on the sphincter mechanism. Bergh and Layne,[2] in a recent article, further substantiate the inconsistent effect of drugs upon the sphincter of Oddi by showing that the commonly used magnesium sulphate produced sphincter relaxation in 33 out of 42 patients. Why it did not affect the other nine, is difficult to explain in the individual cases.

With this confusion of evidence on the effects of various antispasmodics, we endeavored to carry out a series of experiments in such a way that some routine method might be derived to relieve biliary colic both when the gallbladder is intact and when it has been removed. This was worked out on the assumption that most authors agree that atropine in most instances either relaxes the gallbladder and cystic duct area or raises the threshold of irritability and if the inflammatory and pathologic changes in the gallbladder or cystic duct wall are not too pronounced, some decrease in intragallbladder pressure will follow, or the relaxation of the cystic duct area will permit gallbladder contents to empty into the common duct. However, if there is also increased pressure in the common duct and hepatic ducts,

satisfactory relief from the distress cannot be expected until this pressure has been decreased by permitting egress of the common duct contents into the duodenum. If the gallbladder has previously been removed, relief cannot be expected until pressure within the common duct has diminished. The following groups of experiments were made on eight patients who had had previous cholecystectomy and choledochostomy with a T-tube placed in the common duct. Delayed cholangiograms taken about eight to ten days following operation showed a patent common duct in each case.

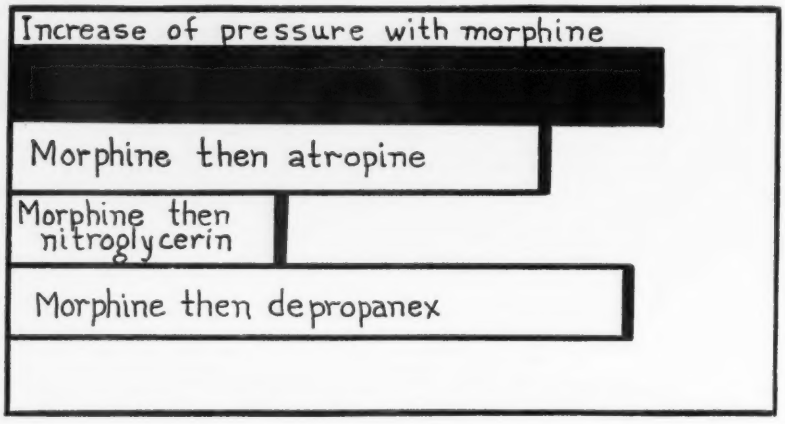

CHART 1.—The columns represent the relative heights of the average pressure levels with the various drugs. In this group, morphine was given first and then the effects of the antispasmodics were recorded with their relative decreases in intraductal pressure.

METHODS OF INVESTIGATION

A water manometer was connected to the T-tube as described in previous experiments.[5] Briefly, the water manometer was adjusted to the estimated level of the common duct, and after filling the entire system with sterile normal saline solution from a bottle which acted as a reservoir, the normal or usual intraductal pressure of that individual was recorded in terms of millimeters of water. Readings were always taken every five minutes for at least 30 minutes. No doubt pressures vary from day to day in the individual patients, depending somewhat on their nervous state, fear, worry and exhaustion, the degree of stomach acidity, the amount, chemistry and physical properties (roughage) of their food, and upon unknown factors. On more than one occasion we have seen an increase in intraductal pressure secondary to spasm of the sphincter of Oddi caused by some rough food, such as a vegetable salad striking the gastroduodenal wall. In some such instances, the patient would have severe colicky pain. We believe a smooth diet is more frequently indicated in the management of biliary tract disease.

Three groups of readings were taken on each patient, after the effects of ¼ grain of morphine on the intraductal pressure were studied. In each case, the morphine caused an increase of the intraductal pressure varying between 10 and 280 mm. of water. In the first group, morphine was

given first (Chart 1), and within a 15- to 30-minute period, the effect of injecting either atropine, nitroglycerin or depropanex on the increased pressure, was recorded. Atropine in $\frac{1}{100}$ grain doses subcutaneously did not cause the intraductal pressure to fall back to its original level in any case, but in five instances it did appear to halt the increasing intraductal pressure at the level where it was when the atropine was injected, or at least to prevent the pressure from ascending to the height it usually reached in that particular case following injection of morphine. With nitroglycerin ($\frac{1}{100}$ grain under the tongue), five of the eight patients revealed a drop in the intraductal pressure varying from only 20 mm. of water to a marked

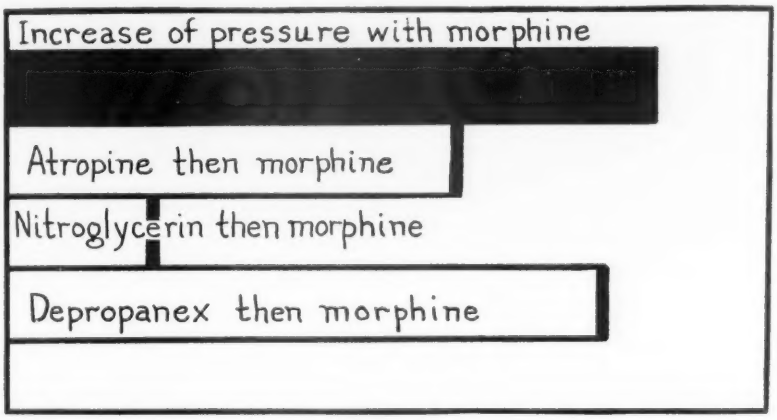

CHART. 2.—The columns represent the relative heights of the average pressure levels with the various drugs. In this group, the relaxing agent was given first, followed by an injection of morphine. As compared with Chart 1, there appears to be a definite advantage in preceding the morphine injection with the antispasmodic since the relative pressure levels are not so high as when the morphine was given first.

decrease of pressure. This decrease lasted varying lengths of time. In the other three cases, the nitroglycerin had a minimal effect on the increase of pressure brought on by the stimulation of the smooth muscle by morphine. Depropanex is a fraction of a deproteinated pancreatic extract derived from beef pancreas and was administered intramuscularly in doses of three cubic centimeters. Some investigators have found it to decrease the claudication time in certain cases of arteriosclerotic disease of the vessels of the lower extremity. Carroll and Zingdale[7] reported, in 1938, that this extract produced relaxation of the ureters and was of definite value in cases of renal colic due to stone and in postcystoscopic colic of the ureters. In the group of eight patients studied, depropanex reduced the pressure only in two instances, and this decrease was very minimal.

In the second group of experiments, the method was reversed, the antispasmodic being given first, followed in about 15 minutes by an injection of morphine (Chart 2). Immediately following the injection of atropine, four of eight cases revealed a definite drop in the intraductal pressure as compared with the control readings for that patient. In all eight cases, the intraductal pressure rose following the injection of morphine, in one case

increasing as much as 120 mm. of water. In the majority of cases, however, the rise was only some 10 to 30 mm. of water. As one compares the curves in this group with those in the first series, it would seem better technic to precede the injection of morphine with atropine rather than give morphine followed by atropine. With nitroglycerin, there was a moderate to marked drop of the intraductal pressure in six out of eight cases. In the other two cases there was no drop in pressure. Then when morphine was injected, an increase resulted in four of the eight cases. As with atropine, it would appear to be more efficacious to precede the injection of morphine with nitroglycerin rather than vice versa. As for depropanex, three of the eight cases revealed a reduction in the intraductal pressure as compared with the

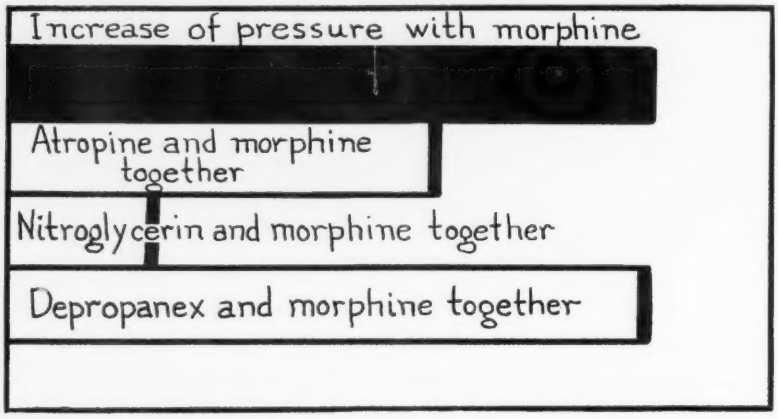
Increase of pressure with morphine
Atropine and morphine together
Nitroglycerin and morphine together
Depropanex and morphine together

CHART 3.—The columns represent the relative heights of the average pressure levels with the various drugs. In this group, morphine and the antispasmodic were given at the same time. The relative heights of the pressure levels about parallel those of Chart 2, indicating there is no advantage in preceding the morphine with an antispasmodic as compared to giving the morphine and antispasmodic at the same time. However, there appears to be a definite advantage in giving the morphine and antispasmodic at the same time rather than giving morphine first and following it with an antispasmodic.

control for that individual. In one instance, this was very slight. As compared with atropine, it was not as efficient, but possibly slightly more prolonged in its action where its antispasmodic properties functioned. In two cases, there was even a slight increase in the intraductal pressure. When morphine followed the injection of depropanex, there was a definite rise in the intraductal pressure in all instances.

In the third group of experiments, the morphine and antispasmodics were given at the same time (Chart 3), and the intraductal pressure readings were compared with those in the previous groups. When morphine and atropine were given together, two of the cases showed a slight drop in the intraductal pressure, two showed only a minimal rise of 5 to 15 mm., and in the remaining four cases, the pressure rose 15 mm. or more. However, as a group, the curve of increased pressure was definitely less than when atropine was given following the injection of morphine, and about the same as when atropine was given preceding the morphine. With nitroglycerin placed under

the tongue at the same time as the hypodermic of morphine was given, three cases revealed a drop in intraductal pressure and in three there was a maximal rise of 5 to 15 mm. In the other two cases there was a rise of 15 mm. or more and as a group the curve of increasing pressure was far less than where the morphine was given first and followed by nitroglycerin. As compared with the experiments when nitroglycerin was first placed under the tongue and then followed by an injection of morphine, there seemed to be no advantage in prescribing it the latter way. As compared with the morphine-atropine combination, the curves were definitely in favor of the morphine-nitroglycerin combination.

In only two cases were readings taken of injecting morphine and depropanex at the same time. In both instances the depropanex did not seem to retard the increasing pressure set up by the morphine.

The drug trasentin was used in 50 mg. doses subcutaneously in three cases. The morphine and trasentin were given at the same time, and although in no case was there a drop in the intraductal pressure, the rise in pressure was minimal in two cases and moderate in one. It seems to act similarly to atropine.

SUMMARY AND CONCLUSIONS

For a patient who has the severe pain that accompanies biliary colic, morphine is definitely indicated for relief. The mechanism of this relief is the blocking effect upon the higher nerve centers but at the same time there is usually aggravation of the increasing pressure within the biliary tract which has effected the onset of pain. An antispasmodic drug which would consistently relax the gallbladder wall, the cystic duct region, and the sphincter area at the lower end of the common duct would not only hasten and prolong the relief in such cases but might also prevent further extension of the pathologic process by permitting free drainage of the biliary tract. In patients with an intact gallbladder, this biliary pain is most frequently due to increasing pressure within the gallbladder. There seems to be sufficient experimental and clinical evidence that atropine has a relaxing effect on the gallbladder wall and cystic duct or at least increases the threshold of irritability, and atropine should be given in conjunction with morphine. With a pathologic gallbladder, one cannot ascertain the status of the choledochal sphincter area. It may or may not be in a spastic state, causing increased pressure in the biliary ducts which would also contribute to the pain. Atropine could be indicated as there is experimental evidence that although this drug is inconsistent in its effect on the sphincter mechanism at the lower end of the common duct, at times it definitely relaxes the sphincter area or at least raises its threshold of irritability. Since this spastic state of the choledochal sphincter may be contributing to pain accompanying the gallbladder colic, and if the morphine-atropine combination has not given relief, morphine by hypo and nitroglycerin by mouth should then be tried 30 minutes to a few hours later because of the more marked relaxing effect of the nitro-

glycerin on the sphincter area. In any event, either atropine or nitroglycerin should be given with morphine to help counteract the tone or spasm stimulating effect of the morphine on intrabiliary pressure. (Chart 1).

In patients who have had a previous cholecystectomy, our experimental evidence and clinical experience suggests that the morphine and nitroglycerin combination should first be tried for biliary colic and if it does not afford relief, one should try a morphine-atropine injection on the assumption that in experiments, nitroglycerin could not always be depended upon to relax the sphincter area and that atropine does at times have a relaxing effect or tendency to increase the threshold of irritability of the choledochal sphincter area.

A good working rule would seem to be to try the morphine-atropine combination first in those individuals with an intact gallbladder and then alternate the atropine with nitroglycerin every four hours. Morphine should be used on the four-hour intervals only as needed. This may be continued over several days, with the hope that between the two different acting relaxing agents the gallbladder and cystic duct area would be sufficiently relaxed to permit egress of thick bile from the gallbladder into the common duct and then, in turn, the sphincter of Oddi be sufficiently relaxed to permit bile to pass into the duodenum.

In those cases where the gallbladder has been removed, the morphine-nitroglycerin combination is most apt to give relief as there is greater selectivity of nitroglycerin for relaxing the sphincter muscles than of atropine. The nitroglycerin is then alternated with atropine every four hours for several days and with the addition of morphine as necessary.

More frequently than not, when we are dealing with an individual with biliary colic and an intact gallbladder, the gallbladder obstructive phenomenon is mostly at fault, while in cases where the gallbladder has been removed, the sphincter mechanism is known to be the spastic obstructive agent.

In our experiments, depropanex was not found to be as efficient as either atropine or nitroglycerin in the management of biliary colic.

Trasentin seems to have qualities similar to atropine, but probably is not as reliable, yet it is a drug which may be used to advantage in some cases of biliary colic.

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MULTILOCULAR SEROUS CYSTS OF THE ROUND LIGAMENT SIMULATING INCARCERATED HERNIAE

REPORT OF THREE CASES

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A GENUINE PRIMARY CYST of the round ligament is a rare lesion, which, when it occurs, can very readily be mistaken for an inguinal or femoral hernia. Careful perusal of standard textbooks in pathology, gynecology, and surgery, fails to reveal any mention of this condition. Since developmentally the round ligaments are derived from the caudal portions of the mesenteries of the mesonephros, and are homologous with the gubernaculum testes in the male,[1] cystic structures in this area may represent persistent embryologic rudiments. From their location it is readily understandable that they be mistaken for incarcerated inguinal or femoral herniae, with which they may be associated.

The literature is replete with reports of solid tumors, leiomyoma, adenomyoma, lipoma, endometrioma, sarcoma, and cystic degeneration of solid tumors in this area. Mayo[2] recently reported 11 cases of leiomyoma of the round ligament, and gave an excellent review of the literature. Hygroma or cystic lymphangioma may occur in the groin. Watson[3] collected 250 such case reports of hygroma, and states that several occurred in the groin, without giving the actual number. These tumors are usually congenital, are seen shortly after birth, and grow very rapidly. They are multiloculated, thin-walled compressible cysts containing serous fluid, lined by endothelium, in contradistinction to true epithelial cysts lined by columnar or cuboidal epithelium.

Endometrial cysts of this region are infrequent, but not of great rarity. Kaulick and Gomori,[4] in 1934, collected 3,000 cases of endometrial cysts. Of these, 60 were in the inguinal area. They added a sixty-first case, a female, age 37, with an endometrial cyst in the labium majus which they mistook for metastatic carcinoma. Beck,[5] Fleming,[6] and Dickinson,[7] have all recently published single case reports of endometriosis of the round ligament. These cysts, often misdiagnosed as inguinal hernia, become swollen and tender during menstruation, conforming to the general behavior of endometriomata. Sampson[8] called attention to the possibility of endometrial implants being carried into the groin by a hernial sac.

We have been able to find only nine case reports in the literature, four of which were histologically verified as true primary serous epithelial cysts of the round ligament. Coulson,[9], in 1859, reported a case grossly similar, but without microscopic description. In 1896, as quoted by Cullen,[10]

Aschenheim described a similar instance of a walnut-sized cyst in the inguinal area attached to the uterine ligamentum rotundum, which contained a clear fluid. Here, too, the descriptive histopathology is lacking.

Martin,[11] in 1937, presented the case of a female, age 43, with a myomatous uterus and a mass in the right groin which was thought to be an inguinal hernia. He performed a supracervical hysterectomy and removed a cystic swelling, the size of a small tangerine, from the extraperitoneal portion of the round ligament at the abdominal ring. On examination, this proved to be a thin-walled cyst lined by low cuboidal epithelium. Schnedorf and Orr[12] report two similar cysts, both associated with indirect inguinal herniae, having single cavities lined by cuboidal epithelium with overlying loose hyaline and fibrous connective tissue. Taussig,[13] in a review of 53 cases of tumors of the round ligament, mentions three cysts, without stating further descriptive criteria. Benchmiol[14] provides the most recent report of a cystic tumor of the round ligament lined by a single layer of cuboidal epithelium, surrounded by connective tissue, and containing occasional elastic fibers.

CASE REPORTS

Case 1.—Mrs. A. C., age 24, first seen June 16, 1937, complaining of a painful mass which had appeared suddenly in her right groin. Examination revealed a tender, firm, smooth swelling, 3 cm. in diameter, in the region of the right fossa ovalis. Cough elicited pain but no expansile impulse. The mass was opaque on transillumination. Because of coincident epidermophytosis, with interdigital fissuring, the initial diagnosis was acute adenitis, and conservative treatment was instituted. The patient was seen again September 18, 1937. The mass was larger and more painful at that time, but she stated that, in the interim, it had become small and had disappeared, but reappeared on straining and coughing. It disappeared again on direct pressure. Examination revealed a tender swelling, 6 cm. in diameter, situated just above the fossa ovalis, fixed to the deep structures and not freely movable. The overlying skin was reddened, but could be moved over it. The mass was irreducible, but on coughing there appeared to be a distinct expansile impulse. There was no vomiting and no evidence of intestinal obstruction. Temperature was 99.4° F.; other physical and laboratory findings were well within average limits, and irrelevant. *Preoperative Diagnosis:* Incarcerated femoral hernia.

Operative Pathology.—The subcutaneous inguinal ring was enlarged and distorted. The round ligament was unusually thick and muscular. This came through the ring as a cord, and spread out fan-wise into a cystic swelling, about 5 x 5 x 4 cm., irregular, nodular, tense, and bluish. The cyst was freed from the underlying structures. The external oblique aponeurosis was incised and the round ligament was traced back to the abdominal ring. There was no evidence of a hernial sac. The peritoneum was opened and the thick muscular round ligament was traced to its uterine attachment. There were no other cysts, and both tube and ovary were normal. The peritoneum was closed, the cyst and distal ends of the round ligament were excised, and the cut end was tacked to the undersurface of the external oblique and to the base of the inguinal ligament The inguinal canal was reconstructed.

Pathologic Examination.—Gross: The specimen consists of a spherical mass 1.5 cm. in diameter with a stem 2 cm. long. The latter is a cord of loose fibrous tissue 1.5 cm. in diameter. The mass is cystic, and on section is multilocular, containing turbid, thin brown fluid. The wall is 1–2 mm. thick The partitions are firm fibrous tissue.

The lining is irregularly finely nodular. *Microscopical:* the cyst lining is made up of a single layer of flattened cells, at times irregularly cuboidal, or of several layers of cuboidal cells. The wall is well vascularized loose fibrous tissue in which run considerable smooth muscle and a few strands of striated muscle.

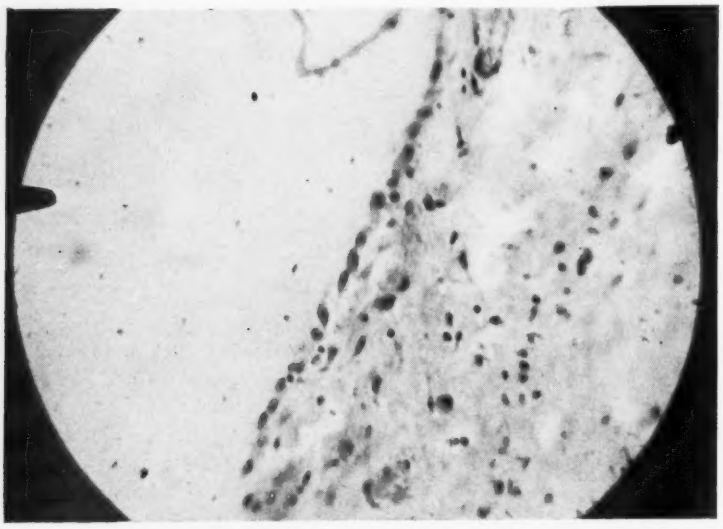

FIG. 1.—Case 2: Photomicrograph showing a multilocular serous cyst of the round ligament.

Case 2.—Mrs. R. E., age 29, first seen June 1, 1938 (service of Dr. N. Reibstein), complaining of pain and a progressively growing mass in the right groin of five months' duration. Pain was intensified on walking. Physical examination revealed a soft, irreducible egg-sized mass in the right groin, with a slight transmitted cough impulse. *Preoperative Diagosis:* Endometrial cyst of the round ligament, although no accom-

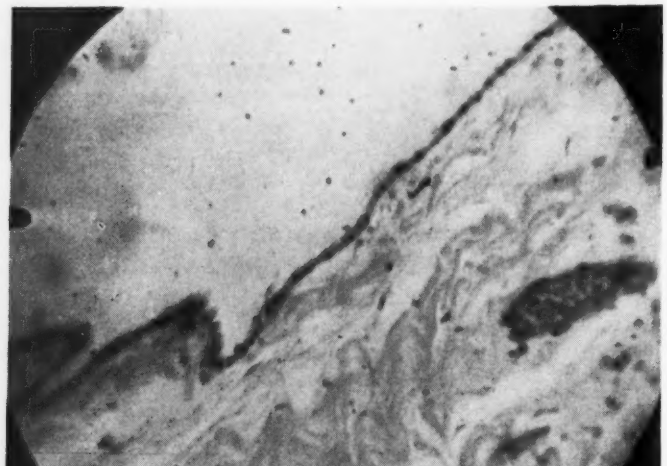

FIG. 2.—Case 2: Photomicrograph showing a multilocular serous cyst of the round ligament.

panying menstrual aggravation of symptoms was noted, or inguinal hernia.

Operation.—A cyst of the round ligament, extending into the labium minus, was excised. A coincident indirect inguinal hernia was repaired. The round ligament was clamped, ligated, and excised together with the cystic mass which was freed by blunt and sharp dissection.

Pathologic Examination.—Gross: The specimen consists of a mass of firm fibro-fatty tissue, 10 x 2 x 4 cm., containing several small cystic spaces. *Microscopic:* Section reveals well vascularized fibro-fatty tissue with densely collagenous areas interspersed, holding several gland-like structures of varying size, lined by low columnar epithelium, ciliated, with dark cytoplasm, serous in type. Some of these are surrounded by a small amount of cellular stroma. Lining of the largest cyst is made up of a flattened cuboidal cell with a small round cell infiltration in the wall.

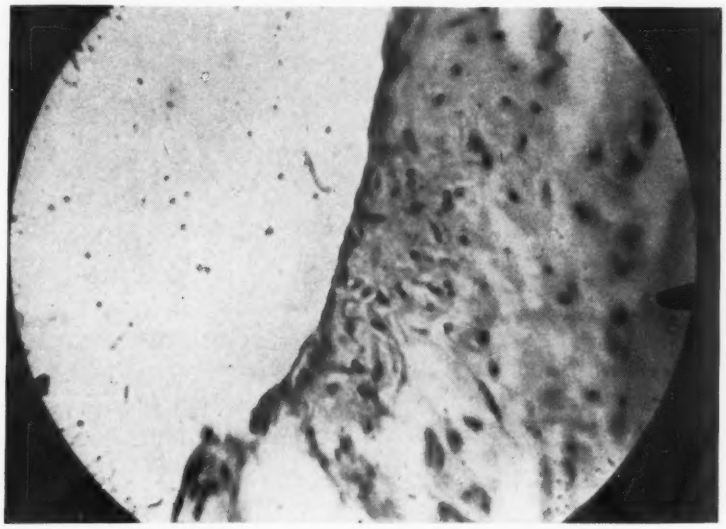

FIG. 3.—Case 3: Photomicrograph showing a multilocular serous cyst of the round ligament.

Case 3.—Mrs. H. G., age 29, first seen June 1, 1941, complaining chiefly of pain in the right groin of one week's duration. For the preceding three weeks she had noticed a persistent small lump in that region. On physical examination, a mass, 5 cm. in diameter, was noted in the region of the external inguinal ring. This was irreducible and had no expansile impulse. *Preoperative Diagnosis:* Incarcerated indirect inguinal hernia or possible endometrial cyst of the round ligament.

Operation.—A completely walled-off, multiloculated bluish cyst, 8 x 4 x 4 cm. in dimensions, was found arising from the distal end of the round ligament and protruding through the enlarged subcutaneous inguinal ring. The abdominal and pelvic peritoneum and adnexa revealed no evidence of endometriosis. The round ligament and cyst were liberated and mobilized, and the distal end of the round ligament and adherent cyst were excised. The stump was attached to the under surface of the external oblique aponeurosis, and the inguinal canal was reconstructed.

Pathologic Examination.—Gross: The specimen consists of a roughly cylindrical mass of tissue, 8 x 5 x 4 cm., irregularly lobulated and cystic in feel throughout. On section, the cysts do not communicate visibly. The fluid is brownish, turbid, and odorless. The cyst wall after evacuation is smooth and dull brown and appears thin and translucent. *Microscopic:* Section shows swollen cuboidal epithelial cells with a central

large somewhat fragmented nucleus and amphophilic cytoplasm are seen to line the cyst in areas. The remainder of the wall is comprised of loose areolar tissue with bundles of smooth muscle fibers infiltrated in scattered fashion by occasional lymphocytes and plasma cells.

SUMMARY

Three cases of nonendometrial multilocular serous cyst of the round ligament simulating incarcerated herniae are reported.

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ACUTE APPENDICITIS DURING THE LATER DECADES OF LIFE: SOME REMARKS ON THE INCIDENCE OF THE DISEASE IN A RURAL AREA

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INFLAMMATORY DISEASE of the vermiform appendix presents to the medical profession a constant challenge in diagnosis and management, constant because of its frequency, a challenge because of the severity and fatality of its complications and sequelae. Statistics from numerous sources show little or no reduction in mortality over a period of many years prior to the use of sulfonamides. Furthermore, in spite of modern surgical technic, recent improvements in anesthesia, and a more comprehensive knowledge of the essentials of preliminary and postoperative care, acute appendicitis, particularly during the later decades of life, still remains an exceedingly serious and often fatal disease.

It, therefore, seems appropriate to present for analysis and consideration the data on 40 patients, fifty or more years of age, with acute appendicitis and its complications, to compare these observations with similar data on 228 patients less than fifty years of age, and to draw therefrom certain deductions relative to the symptomatology, clinical course, management, and cause of death in the older group compared with the younger. All the patients have been treated at the Mary Imogene Bassett Hospital during the years 1931–1940, inclusive.

INCIDENCE OF APPENDICITIS AND ITS COMPLICATIONS

The age-composition of the population in any given community or district determines the morbidity and specific mortality of that locality. Otsego County, in which the Mary Imogene Bassett Hospital is located, is distinctly rural territory and is composed of an aging population. According to the census of 1930 the County with 16.5 per cent of its inhabitants over sixty years of age, "has already reached and probably passed the level at which, in the process of aging, the State as a whole would arrive one generation hence"[1] This fact exerts a profound influence on morbidity in Otsego County and is reflected in the age-incidence of acute appendicitis at the Bassett Hospital. For the purpose of comparing the incidence of the disease according to decades of life in this medium-sized rural institution with its incidence in two large metropolitan clinics, the age-distribution of the patients at the Bassett Hospital has been charted against similar data reported by Walker,[2] from the Boston City Hospital, and by Ray,[3] from the New York Hospital (Chart 1). After reaching a peak during the second or third decade of life[4] each curve falls abruptly to the fifth decade. Thereafter the curves diverge; those representing the urban cases continue to decline while that

illustrating the distribution of the rural cases remains fairly constant until the eighth decade. Expressed numerically only 3.3 per cent of the patients in Walker's series and also 3.3 per cent in the group reported by Ray were over fifty years of age, whereas, 14.9 per cent of the patients treated at the Bassett Hospital had passed the fifth decade of life. This fact is of significance in discussing the mortality of appendicitis at the latter institu-

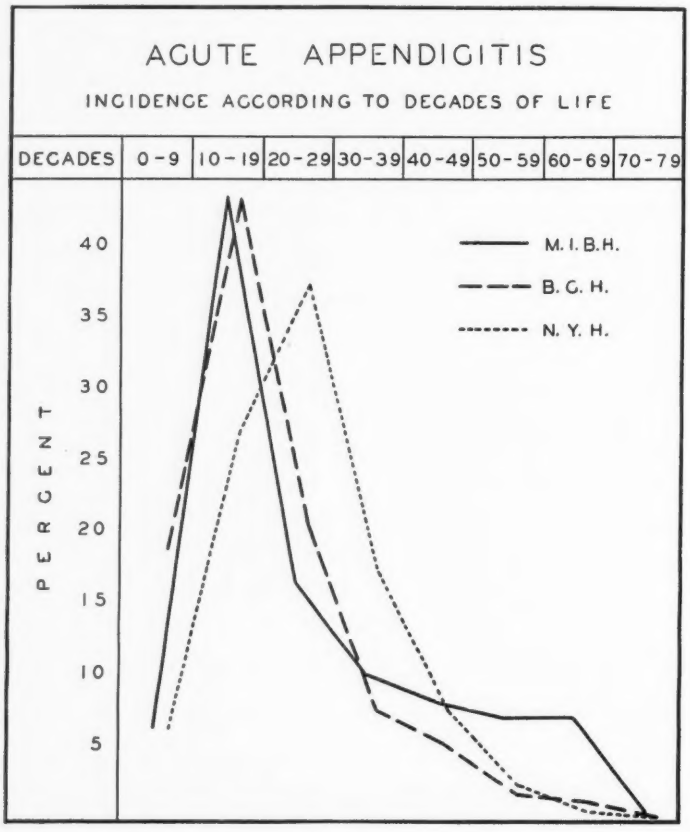

CHART 1.—Incidence of acute appendicitis according to decades of life at one rural and two metropolitan hospitals.

tion and also in considering the morbidity of its complications. In older people the diagnosis of acute appendicitis is often difficult, delayed, and even unsuspected, the complications are frequent and devastating, and the mortality is high.

For the purpose of this study the classification of appendicitis suggested in the Standard Classified Nomenclature of Disease[5] has been elaborated somewhat in order to insure accuracy in the segregation of cases according to the extent and degree of pathology present. Except a few instances in which an obvious appendiceal abscess was drained and the appendix not removed, no case has been included in which the diagnosis of acute appendicitis was not confirmed by histologic examination of the specimen. No case

TABLE I

ILLUSTRATING THE HIGHER PROPORTION OF OLDER PATIENTS AMONG THE TOTAL NUMBER WITH ADVANCED APPENDICITIS AND ITS COMPLICATIONS THAN AMONG THOSE WITHOUT PERFORATION

AGE-DISTRIBUTION OF PATIENTS ACCORDING TO SEVERITY OF DISEASE

Type of Disease	Total Patients	Per Cent Over 50 Years of Age
Acute appendicitis	111	5.4
Ac. ap., with gangrene	53	11.3
Ac. ap., with local peritonitis	11	9.1
Ac. ap., with perforation and local peritonitis	35	25.7
Ac. ap., with perforation and general peritonitis	25	32.0
Ac. ap., with abscess	33	30.3
Total	268	

has been classified as "acute appendicitis with perforation" unless the record contained a definite statement by the surgeon or the pathologist that a perforation existed. No case of peritonitis has been so called unless the peritoneal exudate or pus yielded a positive culture. No patient has been included in the group "acute appendicitis with perforation and general peritonitis" unless the abdominal wall was spastic throughout, the peritoneal infection generalized, according to the opinion of the operating surgeon, and the culture positive. The term "abscess" has been utilized to embrace only those cases in which the history of the illness was long and the collection of pus well localized.

In this series of cases the proportion of middle-aged and elderly people to the total number of patients with simple acute appendicitis, appendicitis with gangrene, or local peritonitis without perforation, ranged from 5.4 to 11.3 per cent. The ratio of older patients to the total number with the more advanced and serious complications of appendicitis, perforation with peritonitis, and abscess, was much higher (25.7 to 32.0 per cent) (Table I).

TABLE II

ILLUSTRATING THE HIGHER INCIDENCE OF PERFORATION WITH PERITONITIS AND ABSCESS AMONG PATIENTS IN THE LATER DECADES OF LIFE

INCIDENCE OF COMPLICATIONS AMONG YOUNG AND ELDERLY PATIENTS

	Under 50		Over 50	
Type of Disease	No.	Per Cent	No.	Per Cent
Acute appendicitis	105	46.5	6	15.0
Ac. ap., with gangrene	47	20.6	6	15.0
Ac. ap., with local peritonitis	10	4.3	1	2.5
Ac. ap., with perforation and local peritonitis	24	10.5	9	22.5
Ac. ap., with perforation and general peritonitis	19	8.3	8	20.0
Ac. ap., with abscess	23	10.0	10	25.0
Total	228	100.2	40	100.0

In fact, the incidence of perforation among these 40 patients who were fifty or more years of age was 67.5 per cent; among the 228 patients in the younger group the incidence was only 28.8 per cent (Table II). The serious significance of this marked variation in the frequency of perforation in these two groups is obvious, and suggests that early gangrene and dissemination of infection to the peritoneal cavity are much more frequent when appendicitis occurs after the fifth decade of life than they are prior to this age.

Furthermore, middle-aged and elderly people are less prone to tolerate operative procedures well, and are more susceptible to the hazards of anesthesia, pulmonary complications, and cardiovascular accidents, all of which must be credited against appendicitis when a fatality occurs.

DURATION OF DISEASE FROM ONSET TO ADMISSION

The reason for the high incidence of perforation with peritonitis or abscess among elderly patients has been ascribed by various authors[4, 6, 7, 8] to delay in seeking medical attention because of frequent previous attacks of "dyspepsia," decreased "sensibility to abdominal pain," the use of some favorite "home remedy," diagnostic difficulties due to the atypical nature of the disease, the dislike of elderly people to accept advice, the "inclination to believe that old age places them beyond the hope of surgery," and various other theoretic conceptions.

TABLE III

ILLUSTRATING THE AVERAGE DURATION OF APPENDICITIS AND ITS COMPLICATIONS AMONG THE YOUNG AND OLD PATIENTS FROM ONSET OF FIRST SYMPTOM TO HOSPITALIZATION

CASES ACCORDING TO AGE OF PATIENTS, TYPE, AND DURATION OF DISEASE FROM ONSET TO ADMISSION

	Under 50		Over 50	
Type of Disease	Number of Patients	Average Length of Illness	Number of Patients	Average Length of Illness
Acute appendicitis	104*	33.6 hrs.	5*	31.6 hrs.
Ac. ap., with gangrene	47	26.4 hrs.	6	26.8 hrs.
Ac. ap., with local peritonitis	10	46.4 hrs.	1	22.0 hrs.
Ac. ap., with perforation and local peritonitis	26	49.6 hrs.	9	39.7 hrs.
Ac. ap., with perforation and general peritonitis	17	49.4 hrs.	8	45.6 hrs.
Ac. ap., with abscess	23	4 7 days	10	9.2 days

One patient excluded because duration of illness was not known.

Actually, no such delay did occur among the 40 patients over fifty years of age in this series. By ascertaining the average duration of illness from onset of the first symptom of appendicitis to arrival of the patient at the Hospital (Table III) it is apparent that, with the exception of the group "acute appendicitis with abscess," the average length of time from onset of acute appendicitis to hospitalization was 36.6 hours for the patients fifty years of age or older, and 36.0 hours for the patients under fifty. In view of the higher comparative incidence of advanced disease among the older group, (Chart 2), it is apparent that appendicitis progresses not more slowly in elderly patients, as suggested by Boyce,[9] and Lewin[10] but actually with equal rapidity. An explanation for the increased duration of illness in the older individuals with well developed appendiceal abscesses is not apparent.

One might suspect that some delay in hospitalization would be incurred by both old and young patients in country towns and farming districts because of the inconveniences of rural life, delay in obtaining a doctor, bad roads, inclement weather, and difficulties of transportation. For the purpose of comparison it is interesting to refer again to the statistics published by Walker,[2] and Ray.[3] In Chart 3 the average duration of illness,

in days, for the 268 patients in both young and old groups at the Bassett Hospital has been plotted against the same data obtained from the cases of acute appendicitis at the Boston City and New York Hospitals. It is interesting to learn that the percentage of patients reaching the Bassett Hospital during the first two days of illness was perceptibly higher than the propor-

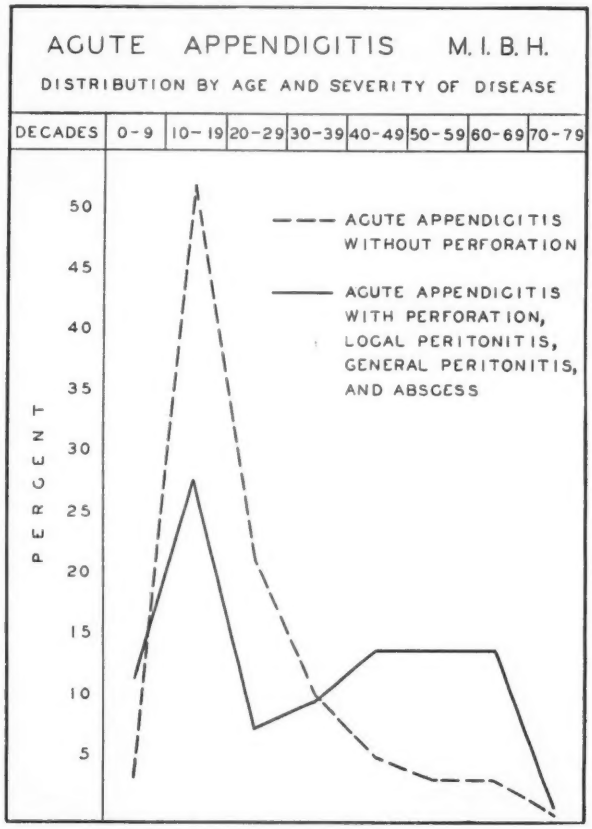

CHART 2.—Graphic illustration of the higher incidence of uncomplicated appendicitis during the second and third decades of life and the greater comparative frequency of perforation with peritonitis and abscess after the fourth decade.

tion of those arriving at the New York Hospital, and much higher than those reaching the Boston City Hospital during the same period of time, a fact highly complimentary to the diligence and skill of the medical practitioners in the towns, villages, and rural sections of Otsego and adjacent Counties.

CLINICAL FEATURES OF ACUTE APPENDICITIS IN ELDERLY PATIENTS

Much has been written about the atypical nature of acute appendicitis in elderly patients.[7, 8, 9, 11] Maes[12] believes that "an acute attack is nearly always preceded by a story of digestive distress over a long period of time." Maes and McFetridge[13] go so far as to state that "any sort of symptom and any sort of circumstance can initiate appendicitis, and the disease, par-

ticularly in late adult life, can take any form at all." Obviously this statement is too broad for general acceptance. It is true, however, that the onset of appendicitis after the fifth decade of life frequently does not assume the classical triad of pain in the epigastrium followed by nausea and vomiting, with later radiation to and localization of pain in the right lower abdominal quadrant. Among those patients at the Bassett Hospital who were fifty or more years of age the first symptom of appendicitis was most commonly pain across the lower abdomen. Among the younger individuals pain in the epigastrium was usually the initial symptom, with pain in the right

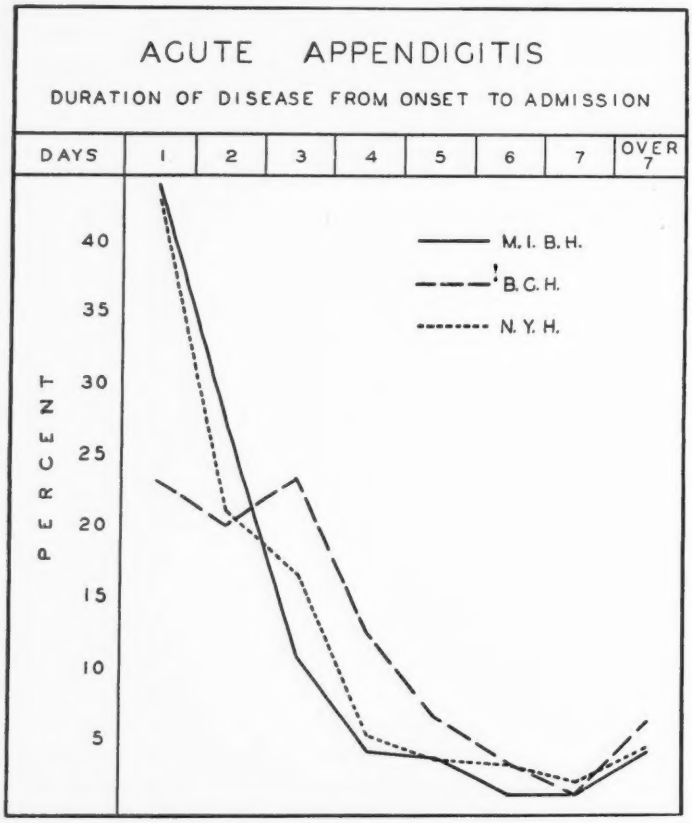

CHART 3.—Graphic representation of the duration of appendicitis among patients at one rural and two metropolitan hospitals.

lower quadrant next in order of frequency. Furthermore, among those patients who had passed the fifth decade of life the pain showed somewhat less tendency to localize in the right side. Otherwise there was no great dissimilarity between the two groups. The bizarre initial symptoms among middle-aged and elderly people which have been reported by other observers were entirely absent in this series. Also there was no prodromal period of "digestive distress," considered by Maes to be so common.

The records were frequently deficient in regard to definite historical data

on the presence or absence of previous similar attacks. However, such statements were available in 191 of the patients less than fifty years of age and in 24 of the older patients. Forty per cent of the former and 46 per cent of the latter had had one or more alleged attacks of appendicitis. This difference is of little or no significance and certainly has no bearing on the more rapid progress of the disease among the patients over fifty years of age.

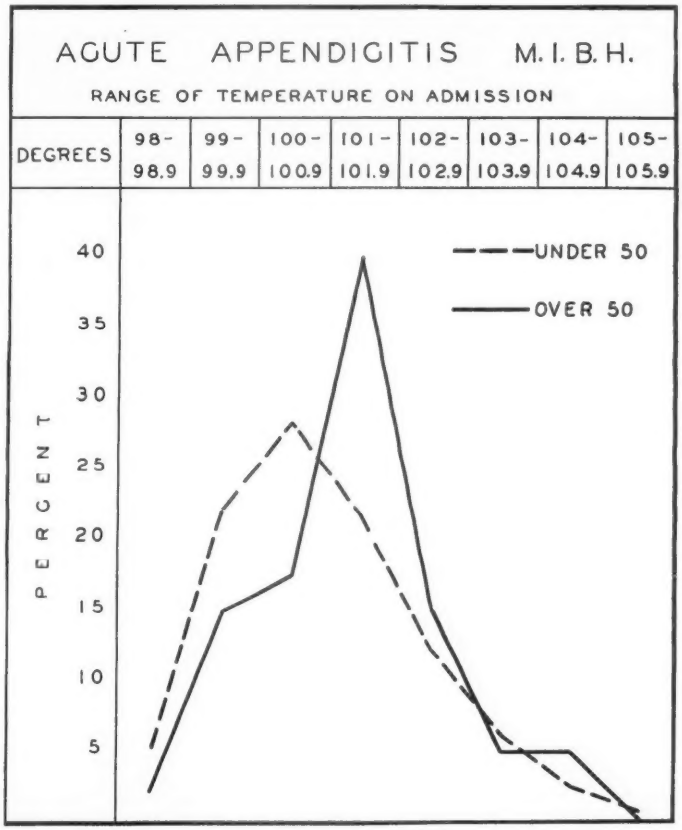

CHART 4.—Graphic representation of the range of initial temperatures among the patients under and over fifty years of age.

The records were also deficient in historical data regarding catharsis during the attack which brought the patient to the Hospital. Definite statements were made in 128 of the younger patients and 21 of the older. Of these, 51 per cent of the younger and 67 per cent of the older had taken one or more cathartics. When considered in relation to the cases in which no information was available, even though this absence of data might suggest that no cathartic had been taken, this difference is likewise probably of little significance and certainly does not account for the much higher incidence of perforation among the older patients.

There was no significant difference in the occurrence of anorexia, nausea,

vomiting, nausea and vomiting, or diarrhea in the two groups. It is interesting that 5.3 per cent of the younger patients and 7.5 per cent of the older had no gastro-intestinal disturbance of any sort.

Shaking chills were twice as common among the older patients, 15 per cent as compared with 7.9 per cent among the younger. Chilly sensations occurred with about equal frequency among the two groups.

In view of the higher incidence of generalized peritonitis among the older patients, tenderness and spasm throughout the entire abdomen were more frequent in this group; signs of localized intraperitoneal infection were more common among the younger patients. Statements regarding the presence or absence of spasm were occasionally at variance with one another.

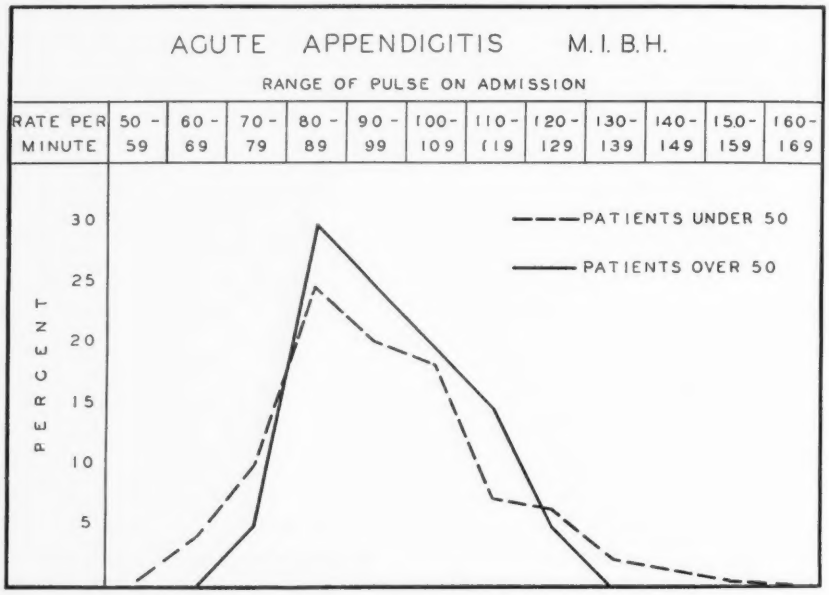

CHART 5.—Graphic illustration of the range of initial pulse rates among the young and old patients.

When any difference of opinion obtained, the statement of the older of one or more examiners was accepted as the more or most dependable. It is frequently difficult to distinguish between voluntary and involuntary rigidity of the abdominal wall, and it is also conceivable that the existence or degree of involuntary spasm may vary from time to time. Considering all these facts as possible sources of error it is, nevertheless, interesting that involuntary abdominal spasm was absent in approximately one-third of the patients in each group.

Abdominal distention was found by Wood[8] in 55 per cent of 43 patients over sixty years of age with acute appendicitis and has been mentioned by other authors,[14, 15] in addition to those previously cited. It is stated by some that distention may be so marked that primary intestinal obstruction due to

neoplasm, or other cause, may be suspected.[16] Among the 40 patients in this series who were fifty or more years of age, abdominal distention was present only as a concomitant of peritonitis.

In brief, although acute appendicitis after the fifth decade of life may occasionally be atypical, the clinical features of the usual attack resemble rather closely those which occur earlier in life and should enable a correct diagnosis to be made in the majority of cases without undue delay.

CLINICAL PATHOLOGY

Data relative to the initial temperature, pulse rates, and leukocytic counts among the middle-aged and elderly patients compared with those in the younger group are presented graphically in Charts 4, 5, and 6. In brief, initial temperatures between 99° F. and 100.9° F. were more common among

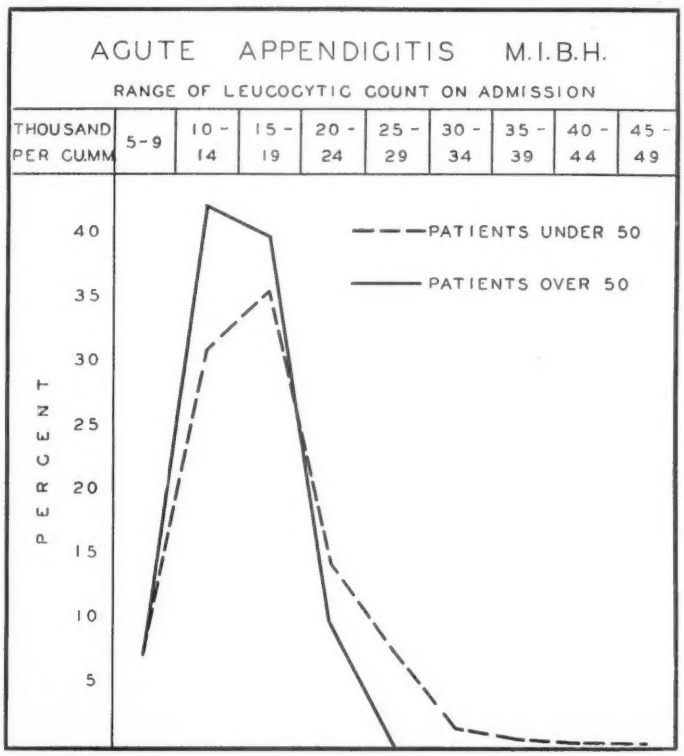

CHART 6.—Curves illustrating the variations in leukocytic counts between the two groups.

the younger patients; temperatures between 101° F. and 101.9° F. were more frequent among the individuals in the older group. In no patient over fifty years of age was the pulse rate more than 129, nor the leukocytic count above 24,000. The widest variations in both were noted among the younger patients, in some of whom the pulse rate was more than 160 and the leukocytic count above 45,000.

OPERATIVE AND PATHOLOGIC DATA

Forty-one per cent of the patients under fifty years of age were operated upon during the first two hours after admission to the Hospital, whereas only 22.5 per cent of the older patients were similarly treated during the same interval of time. In this series of cases appendicectomy with drainage was performed in 55.5 per cent of the individuals in the older group and 33.3 per cent of the younger. Drainage alone was instituted in 20 per cent of the former and 5.3 per cent of the latter. The incidence of appendicectomy with drainage for both old and young was 36.5 per cent; of drainage alone, 7.4 per cent. Drains were not employed solely because of gangrene of the appendix, clear peritoneal fluid, or turbid exudate without odor.

Except in the presence of frank pus, silk was used routinely for removal of the appendix and closure of the abdomen.

The presence or absence, and type, of peritoneal fluid, exudate, or pus in these two groups of cases are shown in Table IV. It is significant and

TABLE IV

INDICATING THE PRESENCE, OR ABSENCE, AND TYPE OF PERITONEAL FLUID AMONG THE PATIENTS IN BOTH GROUPS

CHARACTER OF PERITONEAL FLUID

Fluid	Per Cent	
	Under 50	Over 50
Clear	14.4	7.5
Turbid	29.8	15.0
Pus	25.4	55.0
Not stated	5.3	7.5
None	24.9	15.0

typical that actual pus was present in 55 per cent of the patients in the older group. A culture was not indicated, or negative, in 69.2 per cent of the younger patients and 42.5 per cent of the older. As usual in peritonitis of appendiceal origin *Escherischa coli* alone or in combination with other bacteria, was the predominating organism in all positive cultures.

The close similarity in the position of the appendix in these two groups of cases (Table V) is evidence that its location plays no part in the more

TABLE V

LOCATION OF THE APPENDIX DISCLOSED BY OPERATION

LOCATION OF APPENDIX

Position	Per Cent	
	Under 50	Over 50
Right iliac fossa	28.5	27.5
Pelvis	27.6	27.5
Retrocecal	22.4	17.5
Laterocecal	6.1	7.5
Retroileal	1.3	2.5
Retroileocecal	4.4	5.0
Not stated	9.6	12.5

fulminating type of disease which frequently occurs in middle-aged and elderly persons. The exactly comparable incidence of appendiceal obstruction by fecolith (Table VI) is of interest, and suggestive of a common factor in the etiology of appendicitis in the two groups.

Since 1925, Maes[12] has stressed the importance of vascular occlusion as the etiologic factor in the rapidly progressive type of appendictis in patients who have passed the prime of life. In support of this contention, cited by him and others,[16] are replacement of the lymphatic tissue of the appendix by fibrosis as age increases, the terminal nature of its arterial supply, the greater frequency of total rather than localized, patchy gangrene, the higher incidence of thrombosis and pyelophlebitis, and the presence of generalized vascular disease in middle-aged and elderly patients. Gatewood[15] suggests that many cases of appendicitis in older individuals are embolic in origin.

Fitch,[4] discussing the vascular supply of the appendix, believes that the organ does not atrophy with age but becomes fibrous because of repeated attacks of mild appendicitis, and suggests that circulatory obstruction, when a factor in acute appendicitis, is secondary to distention of the cecum and terminal ileum with fecal material.

It seems quite possible that either of these factors may play a primary rôle in occasional cases of acute appendicitis after the fifth decade of life.

TABLE VI

INCIDENCE AND TYPE OF APPENDICEAL OBSTRUCTION. WHEN NO STATEMENT COULD BE FOUND IN THE OPERATIVE NOTE OR PATHOLOGIC DESCRIPTION RELATIVE TO THE PRESENCE OR ABSENCE OF A FECOLITH, IT IS PROBABLE, THOUGH NOT DEFINITE, THAT NO FECOLITH WAS FOUND.

INCIDENCE OF APPENDICEAL OBSTRUCTION

	Per Cent	
Obstruction	Under 50	Over 50
By fecolith	32.4	32.5
By angulation or torsion	14.5	5.0
No obstruction	10.9	5.0
Not stated	36.8	42.5
Appendix not removed	5.2	15.0

However, there is available too little accurate pathologic information on the condition of the blood vessels in early cases of acute appendicitis in elderly patients to classify all, or even the majority of cases as primarily vascular in origin. It is the opinion of the writer, based on a study of the operative notes and pathologic reports in this series of cases, that vascular impairment, when present, is, in the large majority of cases, secondary to appendiceal obstruction by fecolith, band, kink, or adhesions.

RESULTS AND MORTALITY

The number of patients, the number of fatalities, and the mortality rate for young and old patients in each of the subdivisions of appendicitis and its complications are summarized in Table VII; the causes of death are listed in Table VIII. If the groups be subdivided less completely, and considered only as patients under and over fifty years of age, with and without perforation of the appendix, the following mortality rates are obtained: One hundred sixty-two patients less than fifty years old, with no perforation and no mortality; 13 patients over fifty, with no perforations, two fatalities, each due to pulmonary embolism—mortality 15.4 per cent; 66 patients under fifty, with perforation, three deaths due to peritonitis, one

to intestinal obstruction, and one to pulmonary embolism (patient 43 years old)—mortality 7.6 per cent; 27 patients over fifty, with perforation, two deaths due to pulmonary embolism, two to bronchopneumonia, and one to coronary thrombosis—mortality 18.5 per cent.

Although the incidence of perforation with peritonitis or abscess was much higher among the patients over fifty years of age, no death in this

TABLE VII

COMPARATIVE RESULTS OF SURGICAL TREATMENT OF APPENDICITIS AND ITS COMPLICATIONS AMONG PATIENTS UNDER AND OVER FIFTY YEARS OF AGE

SUMMARY OF RESULTS

	Patients Under 50 Years of Age			Patients Over 50 Years of Age		
Type of Disease	Cases	Fatalities	Mortality	Cases	Fatalities	Mortality
Acute appendicitis	105	0	0	6	2	33.3%
Ac. ap., with gangrene	47	0	0	6	0	0
Ac. ap., with local peritonitis	10	0	0	1	0	0
Ac. ap., with perforation and local peritonitis	26	1	3.8%	9	2	22.2%
Ac. ap., with perforation and general peritonitis	17	3	17.6%	8	2	25.0%
Ac. ap., with abscess	23	1	4.3%	10	1	10.0%

Total mortality patients under 50 years of age— 2.1 per cent
Total mortality patients over 50 years of age— 17.5 per cent
Total mortality all patients— 4.4 per cent

group was due to these complications but rather to cardiovascular accidents and pneumonia, degenerative diseases of advancing years, to which old age is heir, regardless of the intervention of acute appendicitis. In the entire series of cases there were only three deaths from peritonitis; these all occurred among the patients who were less than fifty years of age.

The total mortality for the patients under fifty years of age was 2.1 per cent; for patients over fifty years of age it was 17.5 per cent, and for both groups combined it was 4.4 per cent.

TABLE VIII

SUMMARY OF THE CAUSES OF DEATH AMONG THE FATAL CASES IN THE TWO GROUPS OF PATIENTS

ANALYSIS OF DEATHS

Cause of Death	Under 50	Over 50
Peritonitis	3 patients	0
Intestinal obstruction	1 patient	0
Bronchopneumonia	0	2 patients
Coronary thrombosis	0	1 patient
Pulmonary embolism	1 patient	4 patients

CONCLUSIONS

Acute appendicitis is not uncommon after the fifth decade of life in any community or district with a large proportion of its inhabitants over fifty years of age. The disease is often fulminating in character, and may progress to gangrene and perforation with a rapidity equivalent to, or even greater than in adolescence, youth, or early middle life.

The clinical manifestations may be atypical but more commonly vary so little from those which occur earlier in life that a correct diagnosis in most cases should be made without undue delay provided the possibility of appendicitis be kept constantly in mind.

Appendiceal obstruction is responsible for many of the cases of acute appendicitis during the later decades of life; there is very little concrete evidence to support the theory that vascular changes are of initial importance in etiology.

The complications of local peritonitis, general peritonitis, and abscess are much more common among elderly people.

Appendicectomy, with or without drainage, should be performed as early as possible after the establishment of a diagnosis, and the institution of preoperative supportive treatment when indicated.

Middle-aged and elderly persons tolerate peritonitis of appendiceal origin surprisingly well. The mortality in this group, however, is high. Death is frequently due to the hazards of surgery in old age rather than the toxemia of infection, namely, intercurrent pulmonary complications, cardiovascular and cerebral accidents.

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THE PATHOLOGY OF BURNS

THE PATHOLOGIC PICTURE AS REVEALED AT AUTOPSY IN A SERIES OF 61 FATAL CASES TREATED AT THE HOSPITAL FOR SICK CHILDREN, TORONTO, CANADA

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While the pathologic findings in burns have been reported from time to time, the majority of these reports have been of comparatively small numbers of cases. The largest group recently reported is that of Wilson, MacGregor, and Stewart[1] who described the postmortem findings in 33 cases, in 20 of which a study of the clinical course had been made. Whether any of these cases occurred in the period prior to the introduction of tannic acid therapy is not made clear in their article. To supplement the knowledge thus obtained, we are reporting herewith the findings in a larger series of cases than has hitherto been recorded. This series comprises 61 cases of fatal burns occurring over a period of 23 years (1920–1942). During that period the treatment of all burn cases came under the direct supervision of only three clinicians—the late Bruce Robertson, R. I. Harris and, since 1932, one of us (A. W. F.), while the one pathologist (I. H. E.) was responsible for all autopsy records. This has provided an excellent opportunity for the correlation of the pathologic changes with clinical observations, with methods of treatment and with the survival time. The findings are summarized in Table I, and while the clinical observations and methods of treatment have been dealt with more fully elsewhere,[2]* this article, as the title indicates, has to do chiefly with the pathology. This concerns not only the local skin and adjacent structures, but also such distant organs as lungs, lymph nodes, adrenals, kidneys, liver, and the gastro-intestinal tract. Inasmuch, however, as the changes seem to bear a definite relation to survival time and a possible relation to area burned, and also to treatment, particularly the use of tannic acid, it is proposed to deal with the subject in the light of these factors, perhaps at the expense of some repetition. Since 1928, the surface area burned has been estimated in a manner somewhat similar to that of Berkow's formula.[3] Estimations prior to that date were probably less accurate. The nature of the burn (whether fire, scald, chemical, *etc.*) is also recorded in

* Burn Experiences at the Hospital for Sick Children, Toronto, Canada; Farmer, A. W. Read before the American Traumatic Society in June, 1942. To be published in Surgery. In this article the statement was made that liver damage similar to that seen following the use of tannic acid therapy, was seen also prior to its introduction. However, on reexamination of our material, while a certain degree of fatty degeneration of liver is seen in the pretannic acid period, no actual liver necrosis, such as is seen since the introduction of tannic acid, is found.

Table I, but whether a burn is caused by fire or scald appears to bear little relationship to the pathology. Chemical burns in our experience have been too few to venture any opinion as to the existence of any specific pathologic picture.

TABLE I

SUMMARY OF BURN CASES ARRANGED ACCORDING TO SURVIVAL TIME

Survival Time—One Day or Less

Case No. Age	Type and Size of Burn	Survival Time	Treatment	Clinical Notes	Pathology Findings
1 3½ yrs.	Fire 25%	24 hours	Picric acid	Vomiting, convulsions, high temperature.	Congestion of viscera. Few scattered small hemorrhages.
2 4½ yrs.	Fire 30%	24 hours	Picric acid	Primary shock.	Congestion of lungs, adrenals, and kidneys.
3 5 mos.	Scald 3%	12 hours	No local treatment	Acutely ill, cyanosed. Died a few minutes after admission to ward.	Congestion of lungs, liver and kidneys.
4 8 mos.	Scald 25%	24 hours	Borated vaseline	Vomiting, twitchings.	Congestion of viscera. Tiny hemorrhages in lungs.
5 3½ yrs.	Scald 20%	24 hours	Tannic acid	Vomiting, convulsions, high temperature.	Congestion and petechiae of viscera; edema of pleura.
6 2½ yrs.	Scald 35%	9 hours	Transfusion; no local treatment	Shock.	Congestion of viscera. Numerous small alveolar hemorrhages in lung. Leukocytes in periportal areas of liver.
7 6 yrs.	Fire 80%	12 hours	Tannic acid	Comatose and cyanosed.	Congestion of viscera. Small pulmonary hemorrhages.
8 18 mos.	Scald 25%	24 hours	Tannic acid	Mouth burn.	Liver normal on gross examination. No microscopic section examined.
9 18 mos.	Chemical (lysol) 15%	3 hours	No local treatment	Primary shock.	Fatty liver +.
10 4½ yrs.	Fire 85%	3 hours	No local treatment	Peripheral circulation failed.	Congestion of viscera. Small hemorrhages in alveoli.
11 2 yrs.	Scald 26%	20 hours	Tannic acid	Vomiting, convulsions.	Congestion of lung and liver. Leukocytes in periportal areas of liver. Small hemorrhages in lung.

Survival Time—Two Days

Case No. Age	Type and Size of Burn	Survival time	Treatment	Clinical Notes	Pathology Findings
12 2 yrs.	Scald 15%	2 days	Picric acid	Vomiting, convulsions, high temperature, exsanguination transfusion.	Congestion of lungs, liver, spleen, kidneys, adrenals, fatty liver +, postmortem perforation of esophagus.
13 2 yrs.	Scald 20%	36 hours	Sodium bicarbonate	Vomiting, convulsions, high temperature.	Congestion and edema of lungs, congestion of liver, spleen, and kidneys; kidney damage +*.
14 3½ yrs.	Scald 10%	2 days	Tannic acid	Severe hematemesis, high temperature.	Duodenal ulcer with hemorrhage; large adrenal hemorrhage with rupture.
15 5 yrs.	Fire 20%	2 days	Chrome tanning solution	Vomiting, high temperature, toxemia.	Subpericardial and myocardial petechiae; congestion of viscera.
16 22 mos.	Scald 25%	2 days	Tannic acid	Vomiting, convulsions, high temperature—107° F.	Petechial hemorrhages—subpleural, subpericardial, thymus; fatty liver.
17 3½ yrs.	Scald 55%	2 days	Tannic acid	Toxemia.	Cardiac dilatation; congestion and scattered hemorrhages in periadrenal tissues and floor of 4th ventricle.

*The kidney lesions, apart from congestion, consisted of tubular degeneration, the presence of tubular casts and granular precipitate in the glomeruli. For the sake of brevity the kidney lesions are recorded as "kidney damage +, ++, *etc.*" For further details see Table VI.

Survival Time—Two Days

Case No. Age	Type and Size of Burn	Survival Time	Treatment	Clinical Notes	Pathology Findings
18 1½ yrs.	Scald 10%	2 days	Tannic acid	Toxemia, high temperature—108° F.	Congestion of lungs; large thymus.
19 1 yr.	Fire 3%	2 days	Tannic acid	Vomiting, convulsions, high temperature—106°—108° F.	Congestion of lungs, spleen, kidney; slight fat throughout lobules of liver.
20 3 yrs.	Scald 55%	2½ days (60 hrs.)	Tannic acid	Toxemia.	Edema and congestion of lung; early diffuse necrosis of liver; congestion of viscera; small hemorrhage in thymus and mediastinal tissues.

Survival Time—Three Days

Case No. Age	Type and Size of Burn	Survival Time	Treatment	Clinical Notes	Pathology Findings
21 5 yrs.	Scald 20%	3 days	Tannic acid	Toxemia, vomiting; fall of blood pressure.	Congestion and edema of lungs; early aspiration pneumonia; necrosis of liver +++; kidney damage +++; ulcer of esophagus with hemorrhage.
22 10 yrs.	Fire 35%	3 days	Sodium bicarbonate; exsanguination transfusion	Vomiting, delirium, high temperature.	Congestion of lungs and liver; petechiae of myocardium; previous kidney damage (calcified masses).
23 2½ yrs.	Scald 25%	3 days	Tannic acid	Convulsions and collapse.	Liver necrosis +++; pulmonary congestion; subpericardial and periadrenal hemorrhages.
24 18 mos.	Fire 25%	3 days	Tannic acid	Vomiting, twitchings, toxemia.	Liver necrosis ++; congestion of meninges, liver, kidney and duodenal mucosa.
25 4 yrs.	Fire 20%	3 days	Tannic acid	Convulsions and twitchings.	Liver necrosis ++; kidney damage ++; pulmonary hemorrhage and edema +.
26 9 yrs.	Fire 20%	3 days	Tannic acid	Toxemia.	Lobular pneumonia; liver necrosis ++++.
27 21 mos.	Scald 10%	3 days	Tannic acid	Toxemia.	Liver necrosis ++; kidney damage +++; postmortem digestion of stomach.
28 5½ yrs.	Scald 20%	3 days	Tannic acid	Toxemia.	Liver necrosis +++; early pneumonia; kidney damage +++; postmortem digestion of stomach.
29 3 days	Scald 10%	3 days (14 hrs. after tan)	Tannic acid	Toxemia ?; drowsy but normal temperature; newborn.	Small hemorrhage in heart and lungs; edema of lungs; cloudy swelling of liver.
30 9 yrs.	Scald 25%	3 days	Tannic acid	Vomiting blood, delirious, coma, toxemia.	Liver necrosis +++; acute pulmonary edema; hydrothorax, early pneumonia; kidney damage ++++.

Survival Time—Four Days

Case No. Age	Type and Size of Burn	Survival Time	Treatment	Clinical Notes	Pathology Findings
31 5 yrs.	Fire 10%	4 days	Sodium bicarbonate	Vomiting, convulsions, high temperature.	Slight fatty degeneration of liver; congestion of lungs; slight cloudy swelling of kidneys.
32 2½ yrs.	Scald 25%	4 days	Tannic acid	Twitchings, high temperature.	Liver necrosis ++++; kidney damage +; congestion of viscera.
33 2 yrs.	Scald 50%	4 days	Tannic acid	Toxemia.	Liver necrosis ++++; kidney damage ++; congestion of kidneys.
34 2 yrs.	Scald 15%	4 days	Tannic acid	Toxemia, hematemesis.	Liver necrosis ++++; kidney damage ++++; esophageal erosion; extensive pulmonary edema with congestion and alveolar hemorrhage.

Survival Time—Four Days

Case No. Age	Type and Size of Burn	Survival Time	Treatment	Clinical Notes	Pathology Findings
35 6 yrs.	Fire 35%	4 days	Tannic acid	Toxemia.	Liver necrosis ++++; kidney damage +; jaundice.
36 8 yrs.	Fire 46%	4 days	Tannic acid	Toxemia.	Liver necrosis ++++; kidney damage ++; congestion of lungs with small hemorrhages.
37 2 yrs.	Scald 20%	4 days	Tannic acid	Vomiting, twitchings, shock, toxemia, jaundice.	Liver necrosis ++++; kidney damage ++; ascites; hydrothorax; edema of retroperitoneal tissues; jaundice; esophagitis; gastro-intestinal hemorrhage.
38 10 mos.	Scald 10%	4 days	Tannic acid	Vomiting, restless, high temperature, toxemia.	Liver necrosis ++++; kidney damage ++++; retropleural and retroperitoneal petechiae — widespread; congestion duodenal mucosa.

Survival Time—Five to Ten Days

Case No. Age	Type and Size of Burn	Survival Time	Treatment	Clinical Notes	Pathology Findings
39 22 mos.	Scald 20%	5 days	Exsanguination transfusion. Tannic acid	Vomiting, drowsy, high temperature.	Central necrosis of liver ++ with congestion and hemorrhage; kidney damage +; edema of lung.
40 4½ yrs.	Scald 20%	5 days	Tannic acid; 2 exsanguination transfusions	Vomiting blood, drowsy, coma.	Liver necrosis ++++; kidney damage +++; small adrenal hemorrhage; esophagitis.
41 2½ yrs.	Scald 5%	5 days	No local treatment	Admitted with pneumonia; chest scalded by plaster; drowsy; toxic; melena.	Slight fatty liver; extensive bronchopneumonia; duodenal ulcer; cloudy swelling of kidney.
42 1 yr.	Scald 10%	6 days	Soda bicarbonate; borated vaseline	Scarlet fever, vomiting, convulsions, high temperature.	Liver congested; early bronchopneumonia; cloudy swelling of kidney; small adrenal hemorrhages.
43 13 yrs.	Fire 75%	6 days	Tannic acid	Hemolytic streptococcus septicemia.	Liver necrosis +; early bronchopneumonia; cloudy swelling of kidney.
44 6 yrs.	Fire 40%	7 day	Tannic acid; intravenous saline	Hemolytic streptococcus septicemia.	Liver normal; early bronchopneumonia; duodenal ulcer; cloudy swelling of kidney.
45 3½ yrs.	Fire 20%	7 days	Tannic acid	Admitted with whooping cough. Vomiting, twitching, surgical emphysema, high temperature.	Liver necrosis +++, still hemorrhage in central zones with some polymorphic infiltration; septic pneumonia.
46 2 yrs.	Scald 28%	8 days	Tannic acid	Twitching, labored breathing, sudden collapse.	Liver necrosis—healing stage; kidney damage ++, repair; ulcer of esophagus; pneumonia.
47 4 yrs.	Fire 15%	9 days	Tannic acid	*Staphylococcus aureus* septicemia.	Liver necrosis—healing stage; pyemic abscesses in myocardium, lungs, kidneys; duodenal ulcer.
48 2½ yrs.	Scald 20%	10 days	Exsanguination transfusion; soda bicarbonate; borated vaseline	Toxemia, high temperature—106° F.	Liver, kidney, adrenals, and inguinal nodes congested.
49 9 yrs.	Scald 25%	10 days	Tannic acid	Burns infected, *B. pyocyaneus*.	Liver necrosis—healing stage; kidney damage +; adrenal hemorrhage—widespread; duodenal ulcer; early gastric ulcer.

Survival Time—Eleven Days to Three Months

Case No. Age	Type and Size of Burn	Survival Time	Treatment	Clinical Notes	Pathology Findings
50 4 yrs.	Fire 25%	11 days	Tannic acid	*Staphylococcus aureus* septicemia.	Septic infarct of lung; liver necrosis ++—healing stage; cloudy swelling of kidneys.

Survival Time—Eleven Days to Three Months

Case No. Age	Type and Size of Burn	Survival Time	Treatment	Clinical Notes	Pathology Findings
51 5 mos.	Fire 2%	12 days	No local treatment	Fried pancakes to chest. Diffuse bronchopneumonia.	Bronchopneumonia; very slight fatty liver in central areas; thrombus in ventricle.
52 2 yrs.	Scald 10%	14 days	Sodium bicarbonate; calcium lactate; exsanguination transfusion	Infected transfusion wound, hemolytic streptococcus.	Liver: Slight fatty infiltration; septic pneumonia.
53 23 mos.	Fire 45%	14 days	Tannic acid; exsanguination; transfusion; excision of burn 3rd day (72 hours)	Profound toxemia, twitchings, drowsy, infected transfusion wounds, sepsis, *Staphylococcus aureus.*	Liver: fat vacuoles in periportal and middle zones; septic thrombosis femoral vein (transfusion site).
54 4 yrs.	Fire 25%	19 days	Tannic acid	Hemolytic streptococcus sepsis (infected transfusion wound).	Liver necrosis +—repair, mitoses.
55 9 yrs.	Fire 25%	21 days	Soda bicarbonate; picric acid; borated vaseline, 2 exsanguination transfusions	Severe toxemia early and again last 3 days, with vomiting and high temperature.	Lung: Considerable edema and congestion; small amount cellular exudate. Liver, kidney, mesenteric nodes congested. Axillary nodes edematous.
56 5 yrs.	Scald 5%	21 days	Tannic acid	Hemolytic streptococcus sepsis, scarlet fever, toxemia,	Liver normal; pyemic infarcts in lungs; sepsis.
57 4 mos.	Fire 5%	25 days	Tannic acid	Sepsis, *Staphylococcus aureus.* Infected interstitial site chest wall.	Liver normal; kidney damage +—repair; medullary hemorrhage of adrenal; *Staphylococcus aureus* septicemia.
58 2½ yrs.	Scald 20%	5 wks.	Tannic acid	Sepsis, hemolytic streptococcus and *B. pyocyaneus.*	Diffuse fatty liver ++++; no necrosis; septic pneumonia; thrombosis inferior vena cava and external iliac veins.
59 7 wks.	Chemical Less than 5%	7 wks.	Wet dressings	Child burned at 1 day of age; pneumonia; early malnutrition.	Liver congested, hemosiderin in Kupffer's cells.
60 13 yrs.	Scald 38%	10 wks.	Tannic acid	Septicemia *B. pyocyaneus.*	Diffuse fatty liver ++++; no necrosis.
61 11 yrs.	Fire 25%	3 mos.	Picric acid	Severe toxemia at first. Postoperative shock (3 hours following skin graft operation).	Liver: Fat vacuoles in periportal zone.

Because of the fact that the pathologic changes seen in burns are most pronounced in those cases dying during the periods of what are commonly called secondary shock and toxemia, some explanation of the use of these terms would seem to be indicated. Elsewhere[2] we have expressed the opinion that the symptoms of "oligemic anoxia," called also secondary shock, as well as the other symptoms of "toxemia," are the result of absorption of toxins from the area of the burn, and for this reason have included the so-called secondary shock and toxemia under the one heading. This group of signs and symptoms is easily noted in burns of moderate or severe degree. They include briefly: An elevated temperature, rapid pulse, drowsiness, occasionally disturbed by periods of irritability, which drowsiness may go on to coma and death. Often there are localized twitchings and generalized convulsions. Vomiting commences early in severe burns and may become continuous. The limbs become moist and cold. The blood pressure falls eventually. The urine is of small volume, of high specific gravity, and, in

severe cases, may contain albumin, hyalin and granular casts. Acetone may be present.

In the accompanying charts when the term shock is used as indicating the cause of death, this has reference to primary shock as occurring within the first 12 to 24 hours. The term toxemia, on the other hand, includes what is ordinarily spoken of as secondary shock and toxemia. The survival time is indicated in hours, days, weeks, or months. Where the time is expressed in days the figure used indicates the number of complete days of 24 hours plus part of the day on which the patient died. Thus, if a patient survived more than three full days and less than four full days, the survival time is expressed as four days.

The pathologic findings will be discussed under the following headings with emphasis chiefly on gastro-intestinal tract, liver, and kidneys:

1. Skin and adjacent structures
2. Central nervous system
3. Circulatory system
4. Lymph nodes and spleen
5. Respiratory tract
6. Adrenals
7. Gastro-intestinal tract
8. Liver
9. Kidneys
10. Infection

1. *Skin and Adjacent Structures:* It has long been recognized that the size of the burned area in relation to mortality is of more importance than the depth of the burn. Thus, during the period 1913–1941 there was not a single case of recovery when the burned area involved 50 per cent of the body surface and only one case in which 40 per cent of the body surface was burned. Dupuytren's classification of burns according to depth has long been in common use. This has been graphically represented by Harkins.[4] A somewhat simpler classification is used by the National Research Council of Canada in a recent publication on the Treatment of Thermal Burns.[5] A comparison of the two classifications is shown in Figure I. The classification referred to in this paper is that of the National Research Council. Briefly, the local changes found in burns of the varying degrees may be summarized as follows:

In burns of first degree there is seen dilatation of the capillaries of the corium and the formation of blisters is a characteristic feature. Fluid collects between the dermis and the overlying damaged epidermis. Should the latter rupture, much oozing of serum follows. This is associated also with edema and leukocytic infiltration of the corium. Burns of the second degree involve not only the epidermis but the dermis, together with varying degrees of damage to the sebaceous and coil glands and hair follicles. The amount of scarring may depend upon the depth of the involvement of the dermis while reepithelization is dependent on the extent to which remnants

of the hair follicles and glandular elements have been spared. In burns of the third degree the whole thickness of the dermis has been destroyed.

2. *Central Nervous System:* Our findings here have been rather meager. In some cases permission to examine the brain was not obtained, and in the majority of those in which examination was carried out only vascular congestion and cerebral edema were found. In one instance petechial hemorrhages were found in the floor of the fourth ventricle (Case 17; survival time

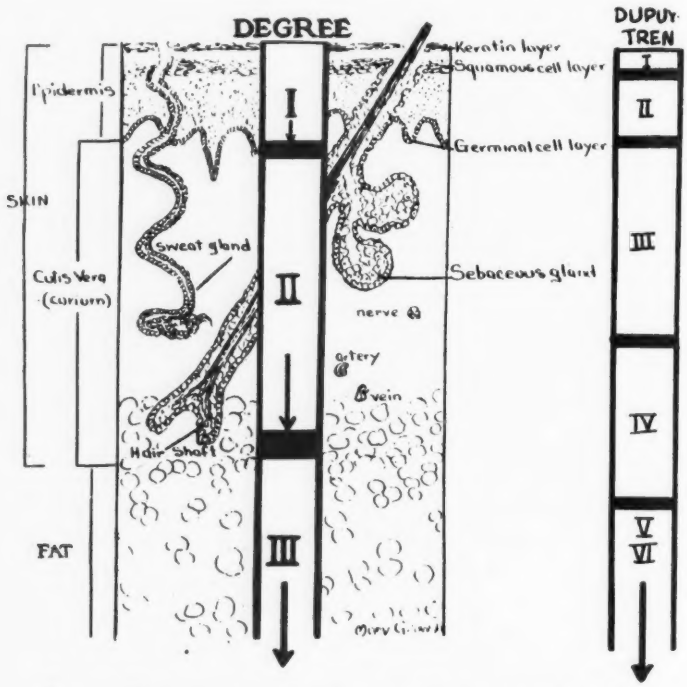


FIG. 1.—Diagrammatic comparison of classification of burns by degrees. Left—according to National Research Council of Canada. Right—according to Dupuytren. Modified from National Research Council of Canada Bulletin 1084.

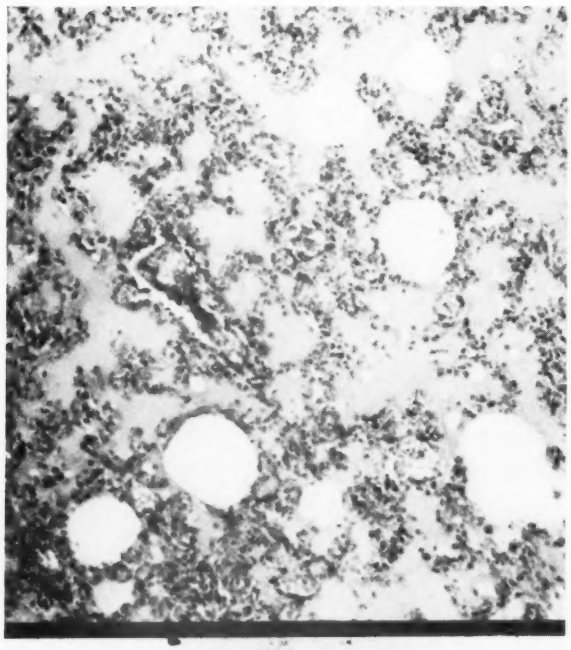
two days). This was associated also with hemorrhages into the periadrenal tissues.

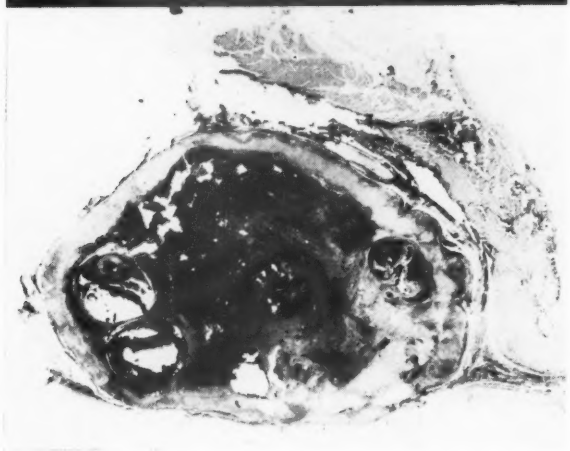
3. *Circulatory System:* Here, again, the changes were slight. In a few instances scattered subepicardial and myocardial petechiae were found, but on no occasion did we see larger hemorrhages, such as have been reported by Harkins[4] in experimental animals. While, clinically, the symptoms of hemoconcentration appear to be the result of loss of plasma from the circulation, no alterations indicating damage to the vessel walls were observed.

4. *Spleen and Lymphatic System:* Apart from swelling and congestion of vessels, with edema and hemorrhage into the interstitial tissues of the nodes, little of a pathologic nature was noted. In some instances this congestion was very marked.

5. *Respiratory Tract:* During the first 24-hour period, apart from con-

A





B

FIG. 2 A. Case 13: S-T—Two days. Pulmonary edema. (H. & E., X 80.)
B.—Case 14: S-T—Two days. Massive adrenal hemorrhage. (H. & E., X 3.)

gestion and petechial hemorrhages, the lungs showed nothing of note. On the second day following the burn, congestion was usually more marked and petechial hemorrhages more pronounced. Edema now appeared in some cases, as shown in Figure 2 A, Case 13. By the third day congestion and edema were still more pronounced, and, should the latter persist, the way may now be paved for the development of a subsequent pneumonia. This complication is dealt with later under the heading "Infection."

6. *Adrenal Glands:* The occurrence of adrenal hemorrhage in burns has

been previously noted.[6] This lesion was observed in four instances in our series. The survival time in these cases was two, five, six, and 10 days

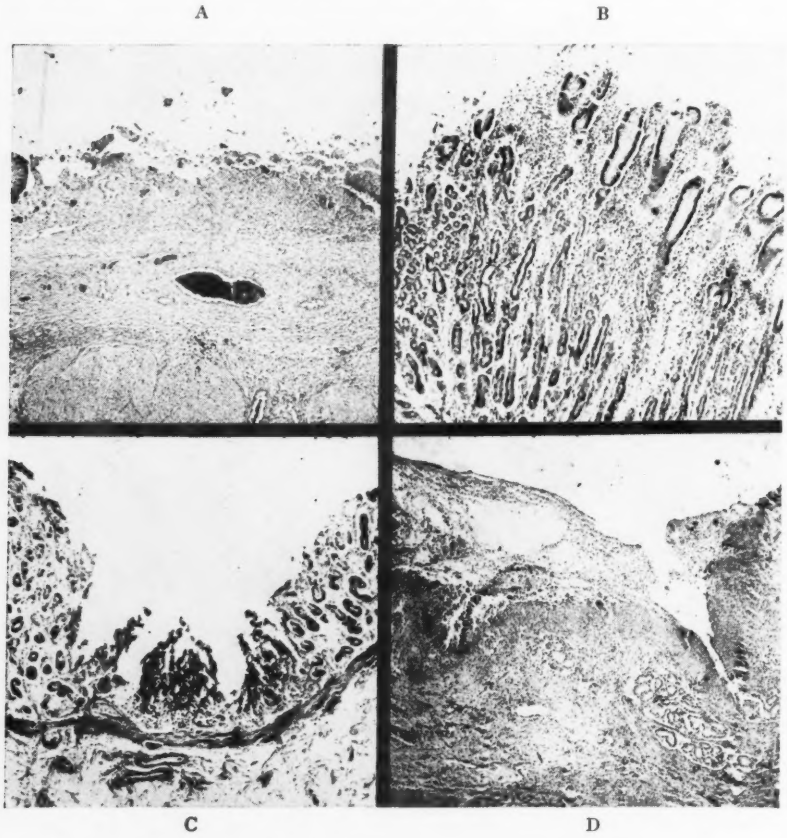


FIG. 3.—Gastro-intestinal Lesions.
A. Case 46: S-T—Eight days. Esophageal ulceration. (H. & E., X 34.)
B. Case 44: S-T—Seven days. Hemorrhage into gastric mucosa, with oozing of blood from mucosal surface. (H. & E., X 48.)
C. Case 49: S-T—Eight days. Early gastric ulcer. (H. & E., X 46.)
D. Case 14: S-T—Two days. Duodenal ulcer. (H. & E., X 34.)

(Cases 14, 40, 42, and 49), respectively. The hemorrhages ranged from quite small medullary ones to more diffuse involvements of the gland, in one instance consisting of an almost spherical mass within the capsule two centimeters in diameter (Fig. 2 B, Case 14; survival time two days).

7. *Gastro-intestinal Tract:* Changes were found in esophagus, stomach and duodenum. In some this consisted only of congestion of the mucosa, while in other cases there was oozing of blood from the congested mucous membrane without definite ulceration. Some of these cases gave a history of vomiting black coffee ground material and in others similar material was found in stomach on postmortem examination. In the esophagus, while varying degrees of superficial erosion were found, in three instances there was ulceration down to the muscularis (Fig. 3 A, Case 46; survival time eight days). The manner in which oozing of blood from gastric mucosa

may occur is illustrated in Figure 3 B. A somewhat more advanced stage of localized epithelial damage is shown in Figure 3 C.

Duodenal ulcers, on the other hand, were found in five cases, or 8.2 per cent, the survival time being 2, 5, 7, 9, and 10 days, respectively. This percentage is somewhat lower than other authors have reported, but, as pointed out by Harkins,[4] some of these reports are based on collected statistics and not on an individual series as is the case in this paper. The percentage of duodenal ulcers in some reports is, therefore, unduly high. One of these duodenal ulcers occurring in a patient dying on the second day is shown in Figure 3 D. This patient had suffered severe hematemesis (Case 14). In another instance there was found in the base of the ulcer an exposed vessel, which again had given rise to extensive hemorrhage (Case 41; survival time five days).

The cases in which ulceration occurred are summarized in Table II.

TABLE II
GASTRO-INTESTINAL LESIONS

Case No.	Survival Time	Tanned	Remarks
			Esophagitis and Esophageal Ulceration
21	3 days	+	Ulceration
34	4 days	+	Ulceration; hematemesis
37	4 days	+	Esophagitis; gastro-intestinal hemorrhage
40	5 days	+	Esophagitis
46	8 days	+	Ulceration
			Duodenal Ulcer
14	2 days	+	Severe hematemesis. Large adrenal hemorrhage
41	5 days	—	Admitted with pneumonia
44	7 days	+	Hemolytic streptococcus septicemia
47	9 days	+	*Staphylococcus aureus* septicemia
49	10 days	+	*B. pyocyaneus* infection of burned area; early gastric ulcer, and adrena hemorrhage

8. *Liver:* Of all the burn changes, those in the liver parenchyma were the most striking. These consisted of first, congestion; then hemorrhage into the central vein areas appeared, accompanied by marked necrosis of the central portion of the liver lobules, involving in some cases two-thirds or more of the lobule. These necrotic changes have been described by Wilson, MacGregor, and Stewart,[1] and Belt.[7] The most extensive damage was found to occur on the third, fourth, and fifth days. Liver function tests were not carried out on our patients; only two of these cases showed clinical jaundice (Cases 35 and 37). In some of those cases surviving this period, regenerative changes were in evidence.

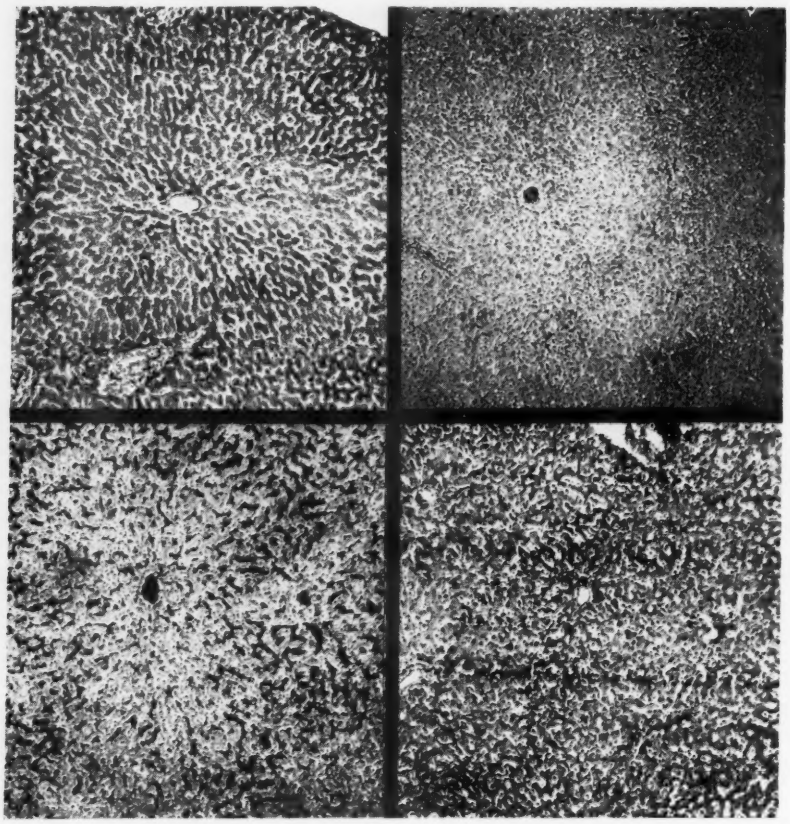
Because of the possible relationship of tannic acid therapy to liver necrosis, as pointed out by Wells, Humphrey and Coll,[8] our series of cases will be divided into untanned and tanned groups. Group I (Table III) comprises 20 cases, approximately one-third of the total series, and included 14 cases in the pretannic acid period, from 1920 to 1924, inclusive, and six cases which occurred subsequent to 1924, in which for one reason or another the burned area was not tanned. In Group II are the 41 cases in which tannic acid was used.

TABLE III
TWENTY UNTANNED CASES

Survival Time	Cause of Death			Total
	Shock	Toxemia	Sepsis	
1-24 hours	5	2		7
2 days		3		3
3-14 days		3	4	7
21 days		1		1
7 weeks			1	1

None showed necrosis of liver. An additional case died of shock following a skin-graft operation, two and one-half months after the burn. Note: Seven of the 20 died in the 3- to 14-day period, when necrosis of liver was a prominent feature in the tanned cases.

A B



C D

FIG. 4.—Photomicrographs of livers from four untanned cases.
A. Case 22: S-T—Three days. Normal liver. (H. & E., X 51.)
B. Case 41: S-T—Five days. Slight fatty infiltration. No necrosis. (H. & E., X 48.)
C. Case 48: S-T—Ten days. Marked congestion. No necrosis. (H. & E., X 51.)
D. Case 51: S-T—Twelve days. Slight cloudy swelling. No necrosis. (H. & E., X 51.)

The Untanned Group: In the first 24-hour survival-period there were eight deaths, and in these the liver showed no pathologic change apart from varying degrees of congestion. In the survival period from 24 to 48 hours

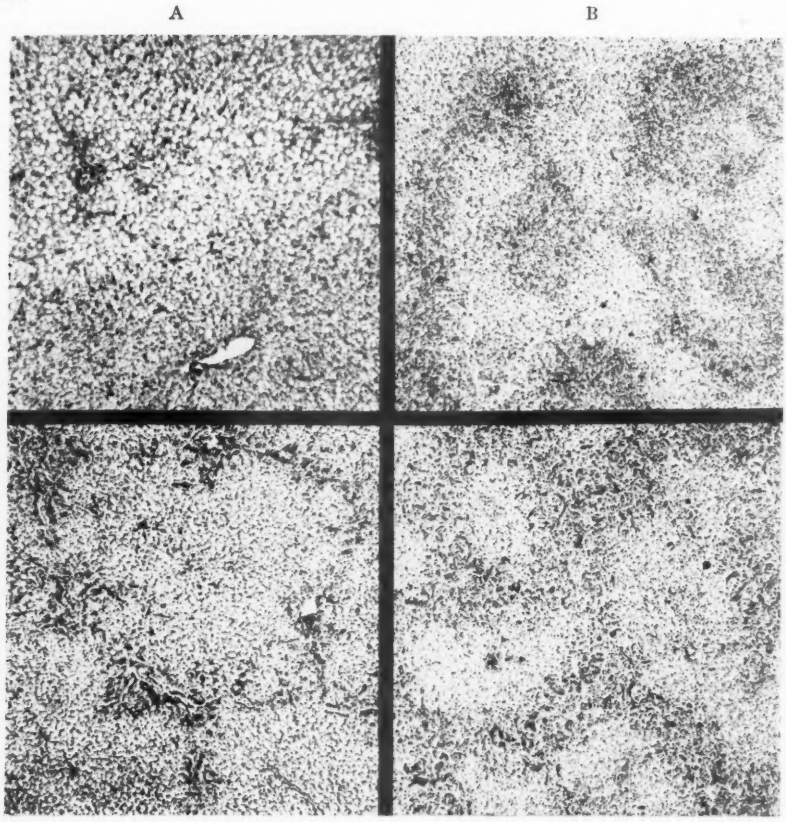


FIG. 5.—Photomicrographs of livers from four tanned cases.
A. Case 20: S-T—Sixty hours. Numerous fat droplets in periphery of lobule with early central necrosis. (H. & E., X 48.)
B. Case 21: S-T—Three days. Marked necrosis. (H. & E., X 34.)
C. Case 32: S-T—Four days. Marked necrosis. (H. & E., X 34.)
D. Case 37: S-T—Four days. Marked necrosis. (H. & E., X 34.)
In C. and D. only a small fringe of relatively normal cells remains.

there were three cases, one of which showed slight fatty change. In the group in which death occurred from the third to the fourteenth day, inclusive, there were seven cases, four of which showed slight fatty change in the liver cells, but in no instance was there anything approaching necrosis. The microscopic appearance of the livers from four of these cases is shown in Figure 4 A, B, C and D. One patient (Case 59), died in seven weeks of pneumonia and malnutrition, and, apart from some congestion, the liver appeared normal. Another patient (Case 61), died three months after the burn of postoperative shock a few hours following a skin graft operation. The liver in this case showed only some droplets of fat in the cells of the periportal zones.

The Tanned Group: These cases are summarized in Tables IV and V. When we consider these, we find very little difference in the first 24-hour period, in which there were four cases. In the 24- to 48-hour period, there were six cases. Two of these showed no changes of significance. Two

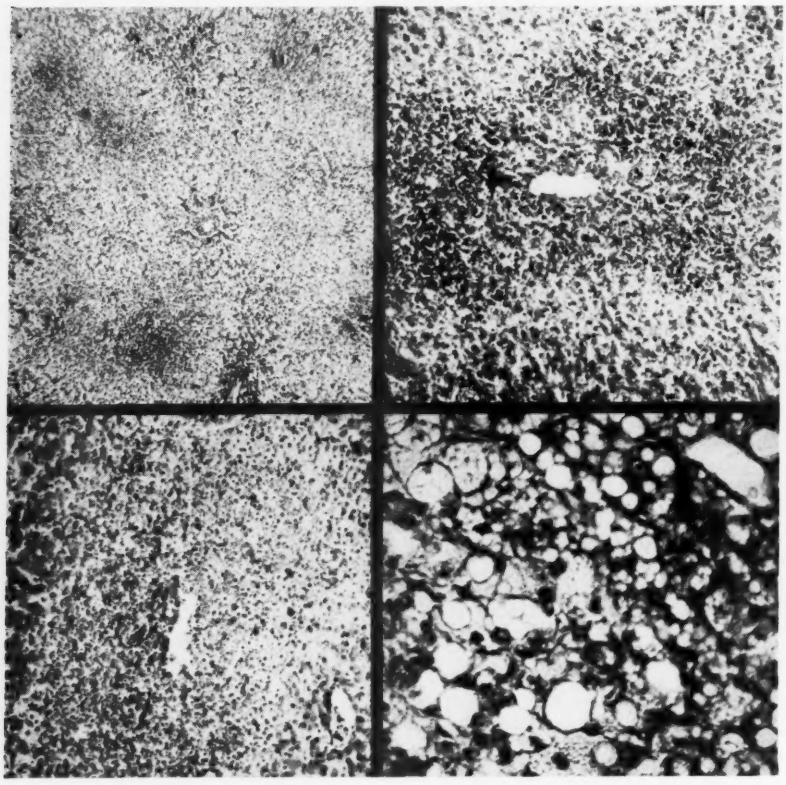
TABLE IV

TWENTY-FIVE TANNED CASES SHOWING LIVER NECROSIS

Survival Time	Liver Necrosis				Cause of Death			
	+	++	+++	++++	Shock	Toxemia	Sepsis	Total
60 hours	1					1		1
3 days		3	4	1		8		8
4 days				7		7		7
5 days		1		1		2		2
6-11 days	1	4	1				6	6
19 days	1						1	1

Note: Seventeen of the 25 died from 3rd to 5th day, inclusive. (See Table VI).

A B



C D

FIG. 6.—Photomicrographs of livers from four tanned cases.
A. Case 38: S-T—Four days. Marked necrosis. (H. & E., X 34.)
B. Case 33: S-T—Four days. Marked necrosis. (H. & E., X 80.)
C. Case 36: S-T—Four days. Marked necrosis. (H. & E., X 80.)
D. Case 40: S-T—Five days. More detail of liver damage. (H. & E., X 240.)

showed early fatty degeneration (Cases 16 and 19). One patient (Case 20) died at two and one-half days (60 hours), and showed widespread fatty degeneration, with beginning central necrosis (Fig. 5 A).

In the eight cases dying on the third day, all showed marked necrosis of central and midzonal areas and extending well out into the outer zone (Fig. 5 B). For comparative purposes the degrees of necrosis are indicated in Table IV as two, three, and four plus. In the group dying on the fourth

and fifth days, there were nine cases, eight of which showed marked necrosis, indicated as four plus (Fig. 5 C and D; Fig. 6 A, B, C and D). In the remaining case the damage, while severe, was less marked.

One patient (Case 43) died of hemolytic streptococcus septicemia on the sixth day. This liver showed what we have described as a one plus necrosis.

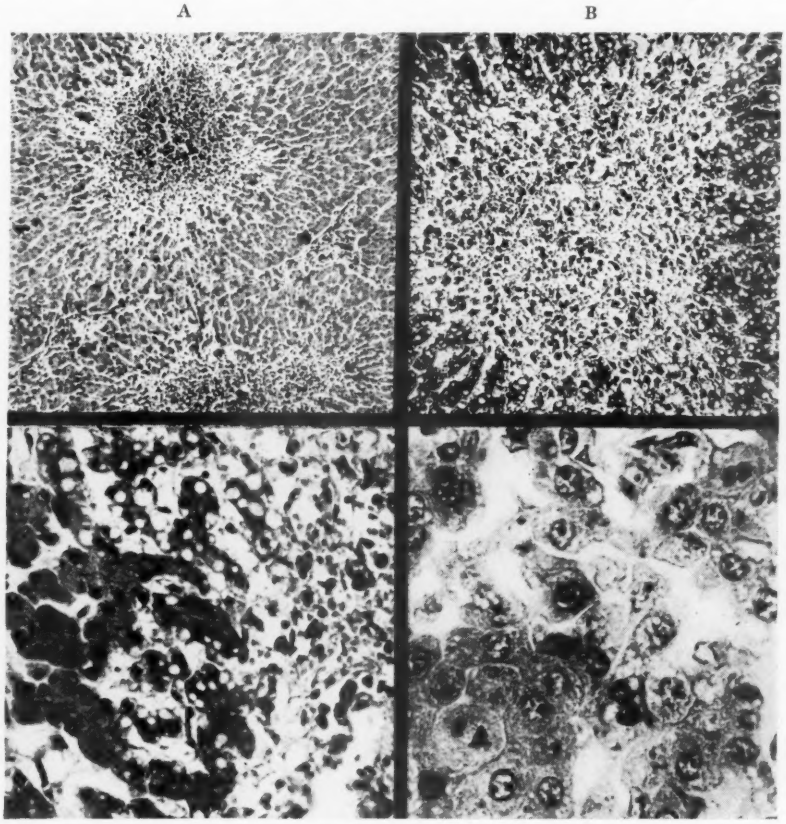


FIG. 7.—Photomicrographs of livers from four tanned cases illustrating process of repair.

A. Case 49: S-T Ten days. Area of necrosis becoming more circumscribed. (H. & E., X 48.)

B. and C. Case 47: S-T—Nine days. Phagocytosis of hemosiderin. (H. & E., X 110 and X 240.)

D. Case 46: S-T—Eight days. Two cells undergoing mitosis. (H. & E., X 510.)

One patient (Case 46) died of pneumonia on the eighth day. Two cases (47 and 49) died on the ninth and tenth days, respectively. These three cases still showed definite central necrosis of liver, but with evidence of healing, in that the necrotic areas were at that time more circumscribed, Kupffer's cells showing phagocytosis of hemosiderin were seen, and in one case mitoses of liver cells (Fig. 7 A, B, C and D).

Of 27 cases dying in the 3- to 19-day period, only three failed to show liver necrosis (Table V). One of these was a newborn infant (Case 29) with a ten per cent burn from a hot water bottle applied at birth; admitted to hospital at two days of age; and tanned only 14 hours prior to death.

TABLE V

SIXTEEN TANNED CASES SHOWING NO LIVER NECROSIS

Survival Time	Cause of Death			
	Shock	Toxemia	Sepsis	Total
1-24 hours	2	2		4
2 days		5		5
3 days		1		1
7 days			1	1
14 days			1	1
21 days-10 weeks			4	4

Details of the three cases dying on 3rd, 7th and 14th days, respectively, are recorded on pages 246 and 248.

Another was the case of a 23-months-old infant (Case 53), with a 45 per cent fire burn, tanned within six hours of admissoin. By the third day toxemia had become so profound that an attempt was made to halt its further development by excising the greater part of the burned and tanned area. Its condition improved for a time, but later a transfusion wound became infected and the child died of sepsis on the fourteenth day. The liver showed only slight fatty change (Fig. 8). The third of these cases

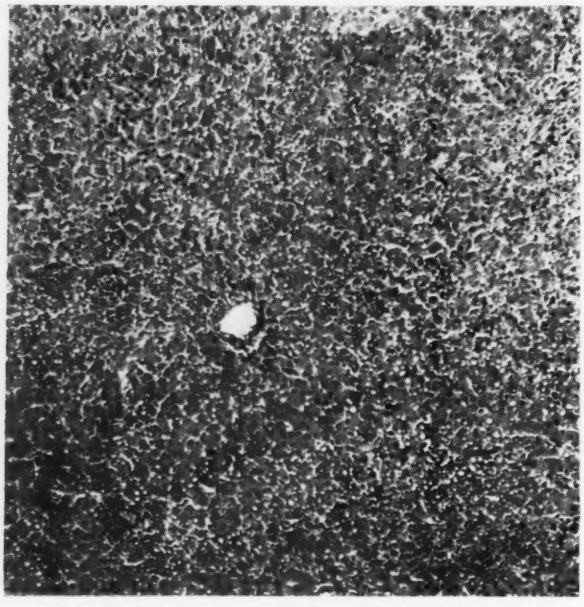


FIG. 8.—Case 53: S-T—Fourteen days. Photomicrograph of liver showing slight fatty change. Burned and tanned area excised on third day. (H. & E., X 51.)

(Case 44) showing no necrosis, was that of a six-year-old girl, with a 40 per cent fire burn (Fig. 9); tanned on admission; and dying on the seventh day, with hemolytic streptococcus septicemia. No gross or pathologic liver changes could be found (Fig. 10). She did, however, have a duodenal ulcer. While she received abundant intravenous saline, she had no glucose solution administered.

The survival times in the tanned and untanned groups are compared in Figure 11. Thus, it is seen that in the untanned group 35 per cent of

deaths occurred within the first 24 hours, while in the tanned group 53 per cent died in the three- to seven-day period. In other words, with the introduction of tannic acid, the average survival time has shifted from the period of primary shock to that of toxemia.

FIG. 9.—Case 44: S-T—Seven days. Burned and tanned area. Death from streptococcus infection.

9. *Kidneys:* The lesions in kidney involved both tubules and glomeruli. The tubular changes consisted of varying degrees of epithelial degeneration, from slight to very severe, with destruction also of many of the nuclei and the presence of numerous droplets of fat in the remaining cytoplasm, particularly towards the basement membrane. In the majority of cases showing epithelial damage, were seen also hyaline and finely granular

casts in both convoluted and collecting tubules, particularly the latter (Fig. 12 A, B, C and D).

Apart from varying degrees of congestion, particularly in those cases dying within the first 24 or 48 hours, the glomerular lesion consisted of deposits of a granular precipitate in the glomerular space (Fig. 13 A, B, and C). The extent to which this was seen is indicated by one or more plus signs in the accompanying Table VI.

TABLE VI
KIDNEY DAMAGE

Survival Time	+	++	+++	++++	Total
36 hours	1*				1
3 days	1	1	2	1	5
4 days	2	3		2	7
5 days	1		1		2
8-10 days	1	1†			2
25 days	1‡				1
70 days	1				1

Note: Fourteen of the 19 cases died from the 3rd to 5th day, inclusive. (See Table IV.)
*The only untanned case.
†Showed repair.
‡Complicated by miliary abscesses.

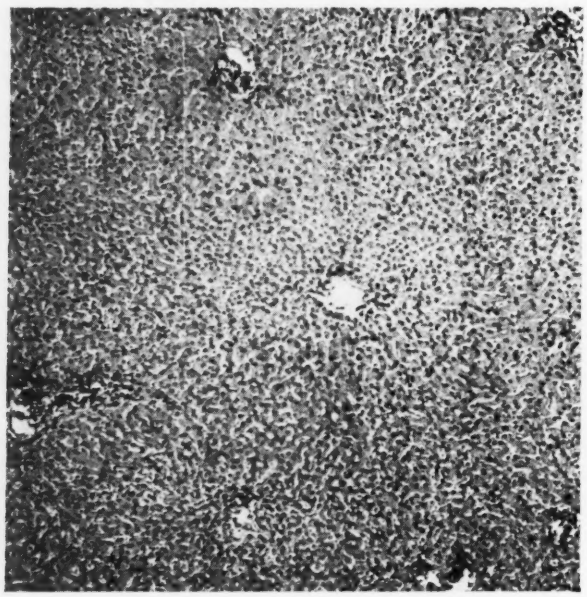


FIG. 10.—Case 44: S-T—Seven days. (See Fig. 9.) Photomicrograph of liver. No necrosis. (H. & E. × 48).

One interesting feature is revealed in the study of the kidney in Case 46, dying on the eighth day. In this case there was no glomerular precipitate. Casts were relatively few and the degenerative changes in the tubular epithelium had altered. While many of the tubules were still dilated and while there was still some débris in the lumina, the majority of the epithelial cells appeared now to have an intact cell membrane. Here and there were scattered epithelial cells undergoing mitoses (Fig. 13 D). These changes

SURVIVAL TIME

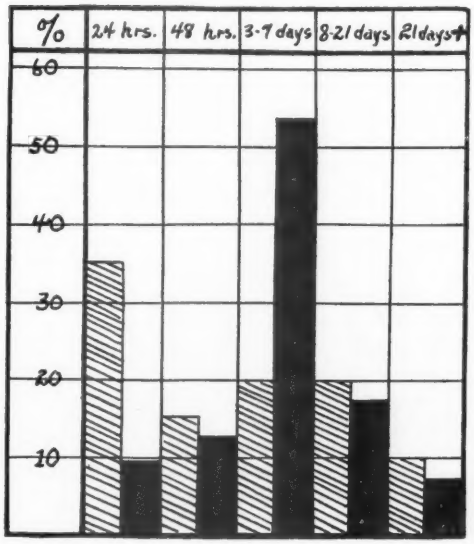


FIG. 11.—Survival Time. Tanned cases solid columns. Untanned cases cross-hatched columns. Note the high percentage of deaths in the first 24 hours among the untanned cases, while the tanned cases reach their maximum from 3rd to 7th day.

are interpreted as evidence of repair. Interestingly enough, this case, which best illustrates repair in the kidney, also shows definite evidence of repair in the liver (Fig. 7 D).

Changes of one degree or another, involving either tubules or glomeruli, were found in 18 of the 61 cases. In only one of these (Case 13, survival time 36 hours) was tannic acid not used, and in this instance the glomerular precipitate was not marked. Neither tubular degeneration nor casts were found.

In Case 57, survival time 25 days, the renal picture was complicated by military abscesses, death having resulted from *Staphylococcus aureus* septicemia. Also, in Case 60, survival time 10 weeks, in which death resulted from sepsis with *B. pyocyaneus* infection, the changes were slight. Of the remaining 15 cases, survival time varied from three to ten days, with 13

TABLE VII
INFECTION AS A CAUSE OF DEATH

Lesion	Survival Time in Days				
	3	5-7	9-14	19-70	Total
Pneumonia on admission		1	1		2
Developed pneumonia	2				2
Whooping cough on admission		1			1
Scarlet fever		1		1	2
Sepsis from					
burned area		2	3	1	6
Transfusion wound			2	2	4
Interstitial wound				1	1

Note: 31 per cent of tanned cases infected.
25 per cent of untanned cases infected.

dying on the third to fifth day. Reference to Table I reveals the fact that everyone of the 15 cases with kidney changes in which there was a survival time of three to ten days, showed also necrosis of the liver. This suggests, at least, that the same noxious agent is responsible for both kidney and liver damage.

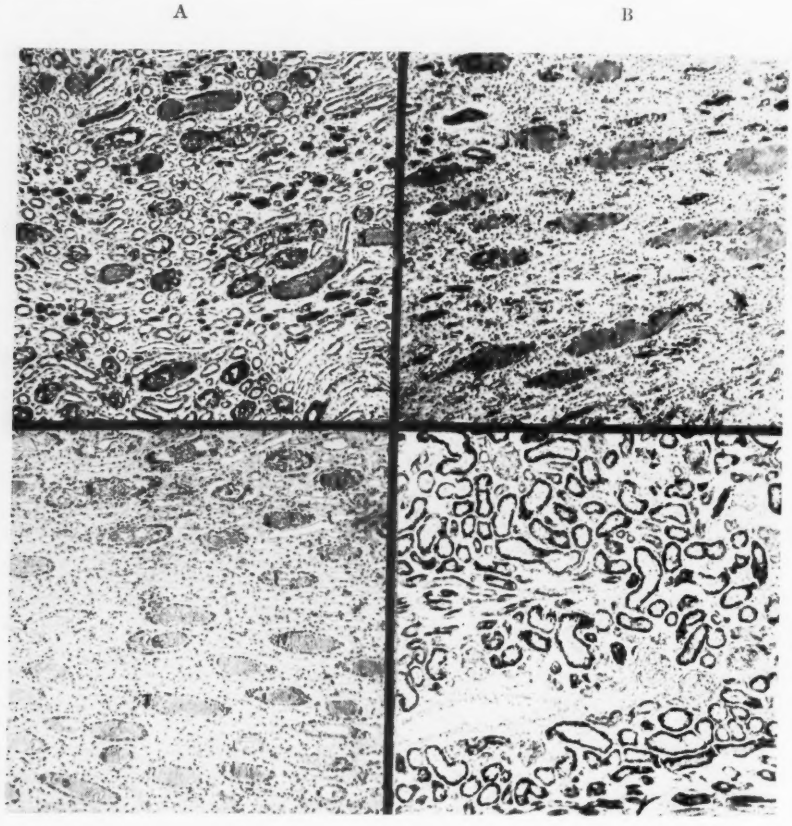


FIG. 12.—Kidney Lesions. A, B, and C, photomicrographs from three cases showing numerous casts in collecting tubules.
A. Case 30: S-T—Three days. (H. & E., X 51.)
B. Case 21: S-T—Three days. (H. & E., X 51.)
C. Case 38: S-T—Four days. (H. & E., X 51.)
D. Showing tubular degeneration with extensive deposits of fat (black) in epithelial cells. Same Case as C. Scarlet red stain. (X 48.)

10. *Infection:* Under the heading "Infection as a Cause of Death" are included 18 cases (Table VII). Of these, two were admitted with pneumonia, the burns having been sustained as the result of injudicious application of a hot plaster in one instance and of hot pancakes in another. One patient was admitted with whooping cough; developed pneumonia; which was complicated by surgical emphysema. Two patients died of scarlet fever, one of which was admitted during the incubation period. Two patients died on the third day, with early pneumonia, in both of which the primary infection appeared to be in the respiratory tract. In six cases

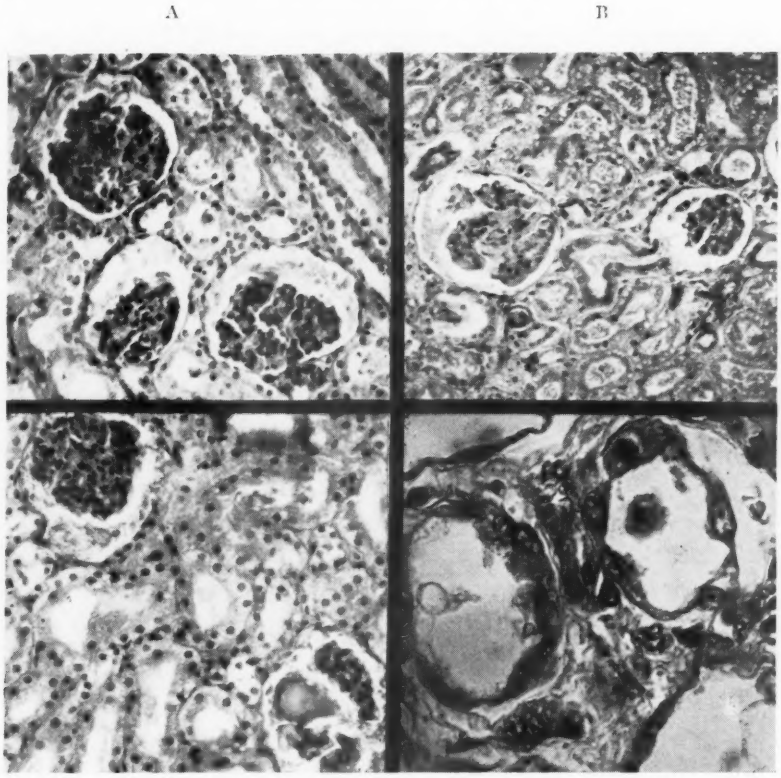


FIG. 13.—Kidney Lesion. A. B. and C. photomicrographs from three cases showing débris in glomerular space; also epithelial damage, particularly in B.
A. Case 27: S-T—Three days. (H. & E., X 160.)
B. Case 34: S-T—Four days. (H. & E., X 120.)
C. Case 40: S-T—Five days. (H. & E., X 160.)
D. Case 46: S-T—Eight days. Tubular repair. One mitotic figure. (H. & E., X 510.)

with septicemia the source of the infection appeared to be in the burned area. In four, transfusion wounds became infected, and in one, infection started at the site of an interstitial saline injection in the chest wall. Ten of these 11 cases were tanned. The invading organism in those cases in which it was identified was as follows: Hemolytic streptococcus, five, *Staphylococcus aureus,* four, *B. pyocyaneus,* two, hemolytic streptococcus combined with *B. pyocyaneus,* one, *B. influenzae* combined with pneumococcus Type X, one.

In Table VIII are shown the burn mortality rates at the Hospital for Sick Children over a period of 28 years. Following the introduction of

TABLE VIII
MORTALITY RATES

Period	Treatment	Mortality Rate
1913-1924	Prior to tannic acid	35.2%
1925-1928	Tannic acid and exsanguination transfusion	16.1%
1929-1937	Tannic acid	11.8%
1938-1941	Tannic acid. Sulphonamides plus plasma, and other measures	2.9%

Note: It is understood that additional therapeutic measures were also taken in all these periods.

tannic acid in 1925, the rate fell from 35.5 to 16.1 per cent, and, again, in the period from 1929–1937 to 11.8 per cent. In the four-year period, 1938–1941, there was a further drop to 2.9 per cent, which has been attributed to the introduction of the sulpha drugs, intravenous plasma, cortin and other measures. The details of therapy are discussed elsewhere.[2]

SUMMARY

1. The postmortem findings in 61 fatal cases of burns are reported. Of these, 41 were tanned with tannic acid and 20 were untanned.

The more important changes remote from the burned area, and apparently of a toxic origin, involve liver, kidney, gastro-intestinal tract and adrenal, while infection of one sort or another takes its added toll. In the gastro-intestinal tract, duodenal ulcer was observed five times, one of which cases was untanned. Esophagitis or esophageal ulceration was observed in five cases, all of which were tanned. Early gastric ulcer, or oozing of blood from gastric mucosa without ulceration, was observed three times. Adrenal hemorrhage occurred four times, in three of which cases the patient was tanned. Renal damage was shown in the form of precipitate in the glomerular space or tubular degeneration and casts. Most of these occurred from the third to the fifth day inclusive. Signs of repair were noted after the eighth day.

2. Of 41 cases in the tanned group, 25, or 61 per cent, showed liver necrosis.

3. The shortest survival time in which necrosis was found was 60 hours, the longest was 19 days.

4. Of the 25 patients showing necrosis, one died in 60 hours, 17 died in the period of three to five days, inclusive, seven died in the period six to 19 days, inclusive.

5. The degree of necrosis was graded as follows: ++++, nine cases; +++, five cases; ++, eight cases, and +, three cases.

6. Death up to the fifth day was attributed to toxemia. Death from the sixth day on was due, in part at least, to infection of one sort or another.

7. Signs of repair of liver were noted in each of five cases, in which death occurred from the eighth to the nineteenth day.

8. Of 27 tanned cases dying in the three- to 19-day period, only three failed to show liver necrosis. One of these was tanned only 14 hours prior to death, and in another the burned and tanned area had been excised on the third day in an attempt to halt the rapidly increasing toxemia. (The child died of sepsis on the fourteenth day).

9. No case of liver necrosis occurred in the untanned group, seven of which died in the three- to 14-day period, in which necrosis was an outstanding feature in the tanned group.

10. Kidney damage was observed in 19 cases, all but one of which belonged to the tanned group.

On the other hand, it should be pointed out:

(1) Following the introduction of tannic acid in 1925, the mortality rate from burns fell from 35.2 to 11.8 per cent prior to the use of sulfanilamides, and to 2.9 per cent since their introduction, along with other measures.

(2) Also following the introduction of tannic acid the time at which death usually occurs has shifted from the early period (first 12-36 hours) into the period of toxemia (third to sixth day), a period in which liver necrosis is most frequently observed.

(3) The patients dying *with* liver necrosis, apart from those dying of sepsis, presented, on the whole, the same clinical picture of toxemia as did those without liver necrosis who were untanned and died in the same period.

(4) The liver necrosis, therefore, whatever its cause, is not necessarily the cause of death, although it may be a serious complication.

(5) It has been shown that this necrosis of liver may undergo repair.

(6) The survival for seven days of one patient with 40 per cent burn, tanned within six hours, and showing at autopsy a normal liver, may point the way to a search for some therapeutic agent to be used in combination with tannic acid, by which the benefits of tannic acid may be preserved and by which, at the same time, the liver may be protected from necrosis, be that necrosis the result of absorption of a toxic substance from the burned skin, the direct or indirect result of tannic acid, or a combination of both.

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THE INTRA-ABDOMINAL USE OF THE MIKULICZ PACK

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THE ABDOMINAL SURGEON is frequently confronted with the problem of dealing with large surfaces which cannot be reperitonealized or covered with omentum after extensive dissections of adherent masses. In regional enteritis, for example, he may be forced to resect a fixed mass involving several feet of small intestine and perhaps a portion of the ascending colon, rendering the entire right lower abdomen a raw, oozing surface. After mobilization of a large neoplasm of the sigmoid, the major portion of the pelvic basin may be denuded of peritoneum.

We have been impressed in these and similar instances with the value of the mechanical exclusion of the small intestines from contact with such areas. If loops of small bowel are allowed to prolapse into a freshly denuded intra-abdominal basin, some degree of obstruction frequently occurs, due to adherence and kinking. In addition, if such an area is infected or contaminated, at least a localized peritonitis will result. The abdomen can withstand peritoneal infection to a marked degree, but the combination of infection and obstruction may frequently be fatal. A mechanical barrier which will cover the unperitonealized surface and fill the space from which a mass has been removed will prevent such an occurrence.

Mikulicz,[1] in 1886, suggested the use of a gauze pack for walling-off large unperitonealized areas after extensive pelvic operations. Little attention was given the "Mikulicz pack," as it was subsequently named, until Faure[2, 3, 4] reintroduced it into France in 1921. Since then, many publications have appeared in the continental literature describing modifications in the technic and extensions of its application. Only a few articles have appeared in the English literature, and we believe the value of this contribution of Mikulicz' may well be restated.

The original Mikulicz pack consisted of a mesh sac, packed with strips of gauze, which was placed into the denuded pelvic basin. The gauze strips were removed gradually, and finally the surrounding mesh sac, leaving a granulating cavity. Faure employed the pack in its original form at the conclusion of the radical Wertheim operation. Following his work, numerous reports appeared, particularly in the French and Italian literature. Descio,[5] Cosma,[6] Patti,[7] Salvini,[8] Dogliotto,[9] Alphonse,[10] Rouhier,[11] Andre,[12] Villard,[13] Audain,[14] Chaton,[15] Sabadini,[16, 17] Dambin and Thomas,[18] Leclercle,[19] Lazarides,[20] Perrin,[21] Keller,[22] Massabrau,[23] Lascaux,[24] Rousseaux,[25] Alcorto,[26] Grigoriu,[27] Andrien,[28] Panchett,[29] Berger,[30] Cadenet,[31] and Corachan and Armangue,[32] discussed the subsequent uses of the pack and its modifications.

The mesh sac of the original pack was replaced by gutta-percha which

had the advantage of easy removal. The indications for the gutta-percha pack were extended widely, and it was used not only to exclude the small intestines from unperitonealized areas, but also to present their prolapse into abscess cavities. Gibson,[33] in 1921, suggested the use of the modified pack in acute appendicitis. Farr[34] reported 162 cases, and Weeden[35] 455 cases

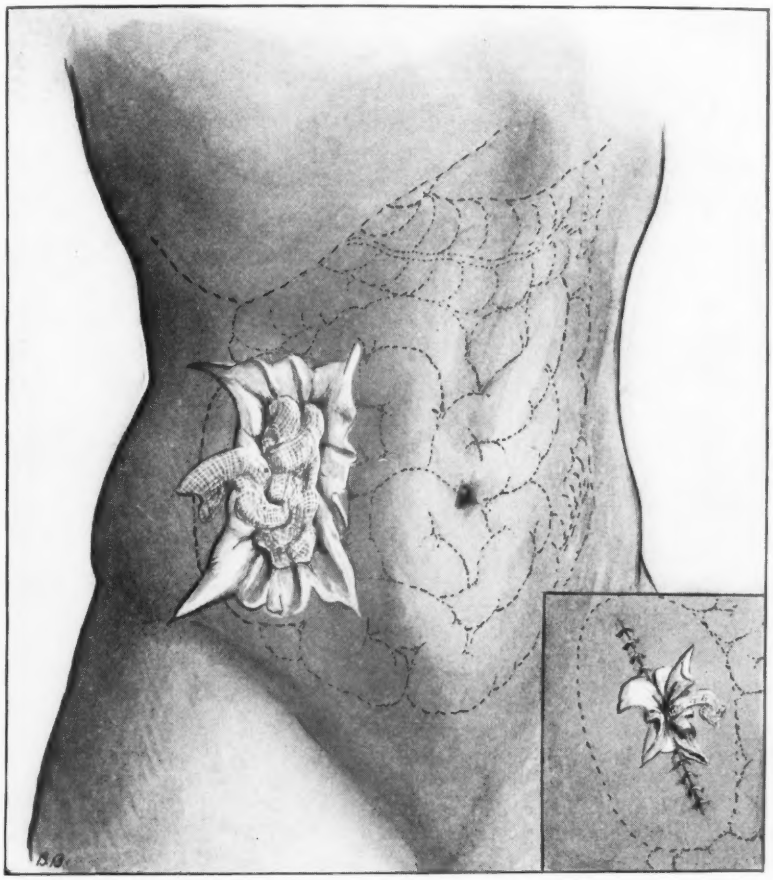

FIG. 1.—Diagrammatic sketch of pack after closure.

using the Gibson technic. Price described the "coffer dam" which may be considered a modification of the Mikulicz pack. Kennedy,[36] a pupil and staunch supporter of Price, practices the principle extensively. Coffey,[37] in 1937, reported a modification using gauze wicks surrounded with rubber dam, and gave a comprehensive review of its application as a mechanical barrier and as a drain. He termed this pack an "abdominal quarantine" which is an apt phrase for the principle.

TECHNIC

For many years the senior author has used a modification of the Mikulicz pack, employing a sheet of rubber dam into which a large fold of gauze

is packed. This may be applied in two ways, depending upon the size and shape of the area to be covered: (1) A large square sheet of rubber dam is placed against an unperitonealized area and packed with a long gauze fold until the cavity formed by the removal of a mass is filled with the

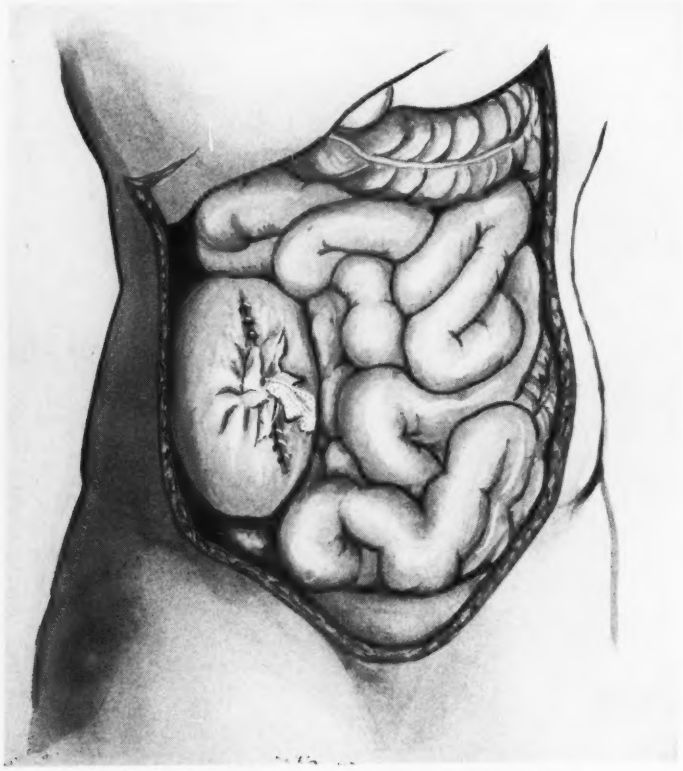

FIG. 2.—Diagrammatic sketch of pack intra-abdominally.

bulk of the pack (Fig. 1). The four edges of the rubber dam square are then gathered together and are brought out of the abdominal wound together with the inner gauze fold (Fig. 1 A). The pack assumes a sac-like shape with the neck at the abdominal wall (Fig. 2). One need not be concerned about the formation of a large intra-abdominal cavity with a relatively narrow opening, since it collapses rapidly within a few days after the entire pack is removed. (2) In the case of a deep, narrow, unperitonealized area, one edge of a rectangular piece of rubber dam is placed into the bottom of the area and folded over gauze packing, forming in appearance a large cigarette drain.

In each case the inner gauze packing is removed gradually beginning the third or fourth postoperative day. The last portion of the pack and the rubber dam are usually removed between the eighth and the eleventh post-operative day. A large rubber tube or catheter is placed into the cavity formed by the pack, and irrigations are carried out as often as necessary

until it closes. With careful postoperative attention such cavities assume the shape of vertical sinuses within a week, and the wounds are entirely healed in six to ten weeks.

USES

We have found this type of pack of greatest value in two groups of cases: First, regional enteritis, especially those cases with enterocutaneous fistulae; and second, neoplasms of the sigmoid colon and the splenic and hepatic flexures.

In regional enteritis with fistula formation, one nearly always finds at operation a densely adherent mass formed by loops of small intestine and often by the ascending colon. Extensive mobilization is necessary, leaving a large raw surface in the right lower abdomen. Furthermore, some degree of contamination is almost unavoidable in the dissection of the sinus tracts. In these cases we believe that the use of the modified Mikulicz pack leads to a smooth convalescence and frequently prevents a mortality which otherwise might be expected.

Neoplasms of the splenic flexure are the bane of surgery of the colon. Mobilization of the lesion is frequently difficult, and a wide area of peritoneum is denuded high in the upper left colonic gutter. It is hazardous to allow the small intestines to prolapse into the cavity formed by the dissection. In such instances, where reperitonealization is impossible, a Mikulicz pack is used routinely to fill this space. The pack is brought out through a stab incision in the left flank. With neoplasms of the hepatic flexure, the same situation frequently exists.

Large, bulky, adherent carcinomata of the sigmoid colon often present difficulties. Frequently, they are surrounded by marked pericolic inflammation and abscesses. Mikulicz pack is the answer to the problem of handling the denuded and infected surface.

The following are typical examples from a series of over 75 cases in which the pack has been used:

ILLUSTRATIVE CASES

Case 1.—Mr. A. M., age 38. *Diagnosis:* Regional enteritis with enterocutaneous fistula. *Operation:* Ileotransverse colostomy and resection terminal ileum and ascending colon in two stages. Resection of adherent mass right lower abdomen involving ileum and ascending colon. About ten feet of bowel resected. Sinus tracts destroyed with cautery. Large denuded area covered with rubber dam pack. *Course:* Uneventful. Entire pack removed by 8th day. Small sinus tract at end of four weeks. Wound healed in six weeks.

Case 2.—Mr. S. L., age 22. *Diagnosis:* Regional enteritis with enterocutaneous fistula. *Operation:* Ileotransverse colostomy and resection terminal ileum and ascending colon. Two-stage operation. Large mass right lower abdomen involving loops of ileum and ascending colon. Six to eight feet of bowel resected. Large unperitonealized area covered with rubber dam pack. *Course:* Uneventful. Entire pack removed 12th day. Sinus closed in eight weeks.

Case 3.—Mrs. B. F., age 56. *Diagnosis:* Carcinoma of splenic flexure. *Operation:*

(1) Preliminary cecostomy. (2) Resection of carcinoma of the splenic flexure. Splenectomy. Large mass bound down to posterior and lateral abdominal walls and to splenic vessels. Separated from lateral wall by blunt dissection. In separation from splenic vessels, hemorrhage occurred necessitating splenectomy. Dissecting posteriorly, abscess was encountered. Mikulicz pack was inserted into hollow produced by splenectomy and removal of mass. *Course:* Dam removed on 8th day. Wound entirely healed in six to eight weeks.

Case 4.—Mr. L. P., age 50. *Diagnosis:* Carcinoma splenic flexure. *Operation:* Mikulicz resection. Neoplasm splenic flexure, adherent to parietal peritoneum and to spleen. Large denuded area high in left colonic gutter filled with Mikulicz pack brought out through stab incision in left flank. *Course:* Uneventful. Pack removed 11th day. Sinus healed in six weeks.

Case 5.—Mr. E. L., age 59. *Diagnosis:* Carcinoma of the sigmoid. *Operation:* (1) Preliminary cecostomy. (2) Anterior resection of the sigmoid. Large mass three inches above peritoneal reflection, diffusely adherent to posterior surface of bladder and to posterior abdominal wall. Peritoneal floor only partially reconstructed. Mikulicz dam inserted into large unperitonealized area. *Course:* Packing began to be removed on 5th day. Dam removed on 10th day. Sinus healed in four weeks.

Case 6.—Mrs. M. B., age 50. *Diagnosis:* Carcinoma of descending colon. *Operation:* (1) Preliminary cecostomy. (2) Anterior resection descending colon. Large mass six inches above peritoneal reflection, firmly fixed to posterior abdominal wall. In freeing mass, fracture of the growth occurred, with extrusion of small amount inspissated feces. Anterior resection performed. Large raw surface remaining after removal of mass. *Course:* One-half pack removed on 7th day; all removed on 8th day. Sinus healed in five weeks.

Discussion.—The omentum often can be employed for covering denuded intra-abdominal surfaces. When its use is feasible no problem exists. In many instances, however, the omentum is short or rudimentary. Even when the omentum is well developed, it is sometimes difficult to use it satisfactorily in covering a large area, especially in the upper colonic gutters. In addition, there is some risk of subsequent obstruction when the omentum is sutured to a fixed point.

The modified Mikulicz pack accomplishes several things simultaneously: First, it serves as a framework for the immediate formation of a protective wall of granulating tissue. It has the effect of limiting the spread of infection from a given area by establishing a counter-reaction in which the surrounding viscera adhere and seal off the general peritoneal cavity. Second, it prevents the contact of the small intestines with an unperitonealized surface during the period in which the peritoneum is reacting to the trauma of mobilization and combatting the infection. Third, the pack acts as a drain. During the first few postoperative days, large quantities of serosanguineous fluid saturate the dressings. This fluid escapes about the imbrications of the rubber dam and acts as a continuous irrigation. The central gauze packing acts only as bulk and has little to do with drainage.

When the pack is removed entirely on the eighth to the eleventh postoperative day, a clean, pliable, granulating surface remains. There is practically no retention of purulent fluid at the bottom of the cavity.

When faced with an adherent inflammatory mass, the surgeon frequently

has to decide whether to proceed with an extensive mobilization, or to be content with a palliative procedure. The risks of the first alternative are greatly lessened by the use of the Mikulicz pack, and more patients may be given a chance for cure. We are certain that the pack has saved the lives of many patients who would have died of peritonitis and obstruction without it.

We have not noticed any of the disadvantages of the pack mentioned in the literature. No herniae of the abdominal wound have been observed at the point of exit of the pack. This we attribute to the use of alloy steel wire in wound closure. No enterocutaneous fistulae have occurred attributable to its use. There have been no residual abscesses or persistent sinuses. These must be guarded against by daily postoperative attention to the wound until the sinuses are completely filled in.

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REDUCTION OF THE MORTALITY IN THE SURGICAL MANAGEMENT OF HYPERTHYROIDISM: THE USE OF THE SHORT INTERVAL TWO-STAGE LOBECTOMY

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The mortality in the surgical management of hyperthyroidism has been lowered to the level of a very safe surgical procedure since the use of iodine in the preoperative management of this disease. This serves primarily to reduce temporarily the degree of hyperthyroidism, so that the postoperative reactions are of a much milder degree. In this manner the principal cause of death in these cases is controlled. Still, there is a small group of severely toxic patients, in spite of the relative decrease in the basal metabolic rate, that have alarming postoperative reactions. It is in this group of cases that most of the deaths occur. As a result of these severe toxic reactions, patients succumb from the effect on the visceral structures. A well compensated heart or liver may be damaged to such an extent by a severe reaction that death results; or moderate reactions may be enough to cause a fatality when associated with an already damaged heart or liver. This was demonstrated in this clinic by a recently reported study on the effect of infection on the liver of hyperthyroid animals.[1]

In 1938, the Surgical Staff at Duke Hospital reviewed the results for the thyroidectomies for hyperthyroidism. The total mortality was found to be 6.94 per cent, and still more significant was the 15.6 per cent mortality in the nodular toxic group. In order to reduce this high figure, a more careful plan of preoperative management was instituted; and a selected group of cases were operated upon in multiple stages. It was not found necessary to do any pole ligations, and all were undertaken as lobectomies. From this change in the management of these cases the mortality was markedly reduced.

No radical change was made in the preoperative preparation other than more careful attention to the details in the management. The patients were placed in a private room at complete bed rest. Iodine and sedation along with a high vitamin, high caloric, high protein, and high carbohydrate dietary regimen was employed. Careful attention was paid to the cardiac and liver status and measures were instituted to prevent complications from poor function of these structures. In choosing the time for operation, the general condition of the patient, the pulse rate, and basal metabolic rate were all considered; and as long as the patient showed improvement, operation was delayed. Some of the patients were prepared for as long as 21 days.

Before 1938 an occasional case had been operated upon in multiple stages (2.43 per cent), with an interval of six weeks between stages. Because of the economic conditions of most of our patients, it was found that this method was not satisfactory. On admission for the second operation the basal

metabolic rate was found to be about the same level as on the previous admission. The patients were difficult to follow and to get back to the hospital, because of the long distances they lived from the hospital. After reading the paper of McGraw,[2] in 1938, it was decided to use the short interval two-stage procedure with 10 to 12 days between each stage.

McGraw reported 161 cases operated upon in multiple stages, with 10 to 12 days between stages that included not only lobectomies but pole ligations. In this group there was a mortality of 7.5 per cent; but in the group that had lobectomies, there was only one death in 48 cases. The incidence of infection was very high (17 per cent for the 161 cases). McGraw did not report any marked reduction in the basal metabolic rate following the first stage. In 1939, Taffel and Harvey[3] reported 52 cases operated upon at intervals of 5 to 15 days, with one death following the first stage. There were three infections in the group, one stitch abscess, one severe infection, and one infected hematoma. Following the first stage there was an average drop in the basal metabolic rate of 14. Both of these clinics used the same incision for the second operation.

By the use of careful preoperative management of hyperthyroid patients, we did not find it necessary to do any pole ligations but were able to perform a lobectomy at each stage. After using the method for a time many advantages were apparent, in addition to the ones already listed. We found that there was a lowering of the basal metabolic rate between stages, and, technically, the operation was much easier at this time than at an interval of six weeks. With the use of ultraviolet radiation[4] there were no infections in the group operated upon in two stages.

It is difficult to describe the indications for a two-stage operation as so much depends on clinical observation and judgment. The evaluation of the patient on entering the clinic is the one factor that bears most weight, as has been stressed by Lahey.[5] A second factor is the patient's response to iodine, rest, and sedation; as measured by the basal metabolic rate, pulse rate, weight, and nervousness. A third factor is the status of the liver, cardiovascular system, and other organs. Other factors are the age, admission basal metabolic rate, duration of the disease, and mental changes. The decision in favor of a two-stage operation was made occasionally at the time of operation because of (1) a tachycardia under anesthesia as high as 180 to 200; (2) a high pulse pressure; and (3) a large consumption of oxygen. In summary, the two-stage operation was elected whenever the preoperative studies or the reaction of the patient to the operative procedure indicated the probability of a severe postoperative reaction.

The operative technic was the same as has always been employed in the one-stage procedure. Silk was used throughout, using both subcutaneous and cutaneous sutures. The incision was reopened for the second stage and again closed with silk. No drains were inserted at either operation.

The change in handling the cases of hyperthyroidism at Duke Hospital

took place about January 1, 1939. The results of all operations for hyperthyroidism performed before this time are compared with the ones after this date. Table I shows the comparison of the mortality along with the per cent of two-stage procedures during these two periods. In the 201 cases operated upon before 1939, the mortality was 6.94 per cent while only 2.43 per cent of the cases were operated upon in two stages. After 1939 there were 176 cases, with 14.7 per cent operated upon in multiple stages, with a mortality of 1.7 per cent. In the nodular toxic group the reduction of the mortality was still more marked, changing from 15.6 per cent, before 1939, to 2.77 per cent after this date (Table II). It was in this group of cases that the main reduction in the mortality took place.

TABLE I
THE MORTALITY AND PER CENT OF TWO-STAGE OPERATIONS
Performed Before and After January 1, 1939

Time	No. of Cases	Deaths	Mortality Per Cent	Percentage of Total Operations Performed in Two Stages
Before 1/1/39	201	14	6.94%	2.43%
After 1/1/39	176	3	1.7%	14.7%

TABLE II
THE POSTOPERATIVE MORTALITY IN TOXIC NODULAR AND TOXIC DIFFUSE GOITERS
Before and After January 1, 1939

Type of Goiter	No. of Cases	Deaths	Mortality Per Cent
Nodular toxic before 1/1/39	64	12	15.6%
Nodular toxic after 1/1/39	72	2	2.77%
Diffuse toxic before 1/1/39	137	2	1.46%
Diffuse toxic after 1/1/39	104	1	0.95%

In summarizing all the causes of death, it is seen that the thyroid crisis, or storm, is the principal reason, resulting in 63.5 per cent, or in 11 of the 17 deaths. The other causes of death are incident to any major surgical procedure. After January 1, 1939, there was only one case dying as a result of a postoperative thyroid crisis and this case was operated upon as a one-stage procedure. The causes of death are listed in Table III.

TABLE III
THE CAUSE OF DEATH FOLLOWING OPERATION FOR ALL CASES
Before and After 1939

Cause of Death	No. of Deaths	Mortality Per Cent
Postoperative thyroid crisis	11*	63.53%
Died on operating table	2*	11.77%
Cerebral embolus	1	5.82%
Pulmonary embolus	1	5.82%
Bronchopneumonia	1	5.82%
Coronary occlusion	1*	5.82%

*One case of each group died after January 1, 1939. Total of three cases.

Of the 25 cases operated upon in multiple stages there was only one death. This occurred during the first operation from what was thought to be ventricular fibrillation from cyclopropane anesthesia, as the patient was fibrillating before operation. As a result of this we began to employ ether in all cases having cardiac complications. The one death in this

group gave a mortality of four per cent, but the mortality in this group is bound to be high as this is a select group of poor risk patients. The best interpretation of the results is the effect on the overall mortality of performing two-stage operations.

Table IV shows the comparison of the basal metabolic rate of patients operated upon in one and two stages. The average basal rate was found to be plus 36.64 per cent in the cases operated upon in one stage as compared to plus 61.83 per cent average basal metabolic rate for the cases operated upon in multiple stages. Before operation the basal metabolic rate in the one-stage group fell to plus 18.52 per cent, as compared with plus 29.92 per cent in the two-stage group. The age in the two-stage group averaged two years greater than the one-stage group. The two-stage cases had cardiac damage in 43.3 per cent, and liver damage in 6.5 per cent.

TABLE IV

COMPARISON OF THE AGE OF THE PATIENT AND THE B. M. R. FOR SINGLE AND MULTIPLE-STAGE OPERATIONS

Performed After January 1, 1939

Operation	Average B. M. R. on Admission	Average B. M. R. Just Before Operation	Average Age in Years
One stage	Plus 36.64%	Plus 18.52%	35.28
Two stages	Plus 61.83%	Plus 29.92%	37.2

In all our cases there was a fall in the basal metabolic rate following the first stage to a level usually lower than the last pre-operative basal rate. The average for the group was plus 24.1 per cent when recorded on the 8th to 10 postoperative day. All the patients were kept on iodine following the first stage operation.

CONCLUSIONS

Deaths following thyroidectomies for hyperthyroidism, in the majority of cases, are due to postoperative thyroid reactions. The incidence of severe reactions has been reduced by the employment of iodine in the preparation of these patients for operation. In a small group of seriously ill patients the operative mortality is still quite high as a result of thyroid crises. If the mortality for the entire group is to be reduced, then measures directed toward the prevention of these reactions is necessary. Our experience, since 1939, has shown that careful and detailed preoperative care followed by use of two-stage operations in the more seriously ill patients will reduce the incidence and severity of thyroid crises. When this reduction in the postoperative reactions takes place, then the mortality falls. As one performs more operations in two stages there is a reduction in the mortality. The significant fact in the mortality figures is not the deaths in the two-stage operations, but the reduction in the mortality of all cases of hyperthyroidism operated upon.

A two-stage operation should be undertaken in all poor risk patients. As Lahey[5] has stated, any patient that has a severe postoperative reaction should have been operated upon in two stages. At Duke Hospital we have

not performed any pole ligations nor have we undertaken any operations upon thyroid patients as emergency procedures. If a patient cannot be brought into condition to stand a lobectomy, operation had better be deferred, as by careful handling nearly all can be improved to such an extent that surgery can be undertaken. The ones that do not improve stand no chance of surviving a surgical procedure.

The two-stage lobectomy performed at 10 to 12 days between stages, has proved to be the most satisfactory method of undertaking multiple-stage operations. With the employment of ultraviolet radiation there is very little danger of infection from opening the wound for the second stage. It has been our experience that the patient's basal metabolic rate is much lower at ten days than it is at the end of six weeks. The operative procedure is much easier at this time than at a later date.

SUMMARY

1. The majority of deaths following thyroidectomy for hyperthyroidism are due to thyroid crisis.

2. Measures directed toward prevention of these reactions will lower the postoperative mortality.

3. Careful preoperative management and the employment of the two-stage procedure in poor risk patients reduced the mortality at Duke Hospital from 6.94 to 1.7 per cent.

4. The short interval two-stage procedure is suggested as the best method for carrying out the two-stage operation.

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ECHINOCOCCUS CYST OF LUNG EXHIBITING UNUSUAL RADIOLOGIC AND SURGICAL FEATURES

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ALTHOUGH echinococcus disease is rare in this country, it is common in Australia, Iceland and the Argentine. Next to the liver, the lung is the most frequent site of localization of hydatid cysts. Their location in the lung may be central or peripheric, and the latter type may increase in size to such an extent that contact with pleura occurs. With the extension to the pleura, pleural pain is of frequent occurrence and may be the only symptom causing the patient to seek medical aid.

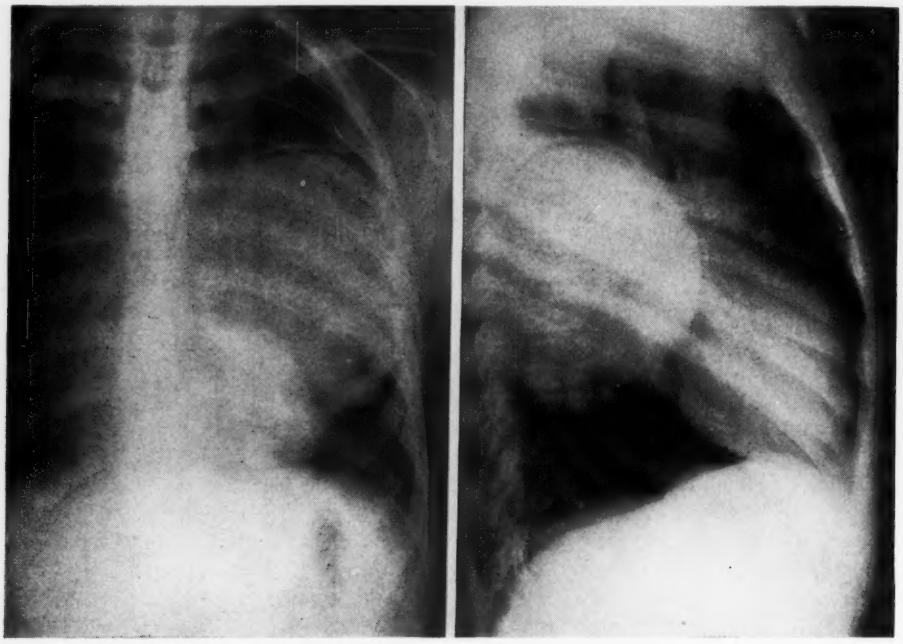

FIG. 1.—Radiograms exposed in postero-anterior and right lateral projections showing the large ovoid mass of the hydatid vesicle separated from the capsule of the adventitia by a crescentic air space superiorly and to a lesser extent inferiorly.

The case we are reporting is of particular interest as it illustrates a radiologic manifestation which has been regarded by South American writers as a pathognomonic sign, and because of the unique surgical experience in treating the patient.

Case Report.—R. DeL., white, male, age 12, had lived in Italy until coming to the United States in 1937. He was admitted to the Children's Hospital of Michigan, March 16, 1942, complaining of a pain in the left side of the chest in the region of the

midaxillary line, accompanied by a dry cough of ten days' duration. There had been some progressive loss in weight, weakness and pallor for about six months. He was said to have had a similar attack of pain and cough with some fever in the preceding year.

The physical examination disclosed dullness on percussion of the left side of the chest posteriorly, with diminished breath sounds and fine râles at the base. The temperature, pulse and respirations were normal, as were the routine laboratory studies of the blood and urine. There was no eosinophilia. The tuberculin skin test and the Kline test for syphilis were negative.

Radiologic examination, March 16, 1942, disclosed a sharply circumscribed shadow in the left midchest posteriorly, measuring 10.5 x 8.5 cm. (Fig. 1). The shadow was of uniform density except for the appearance of a capsule at the periphery, with a layer of air between the capsule and the mass itself. This phenomenon was not explained, and a presumptive diagnosis of a benign tumor was made. Upon reexamina-

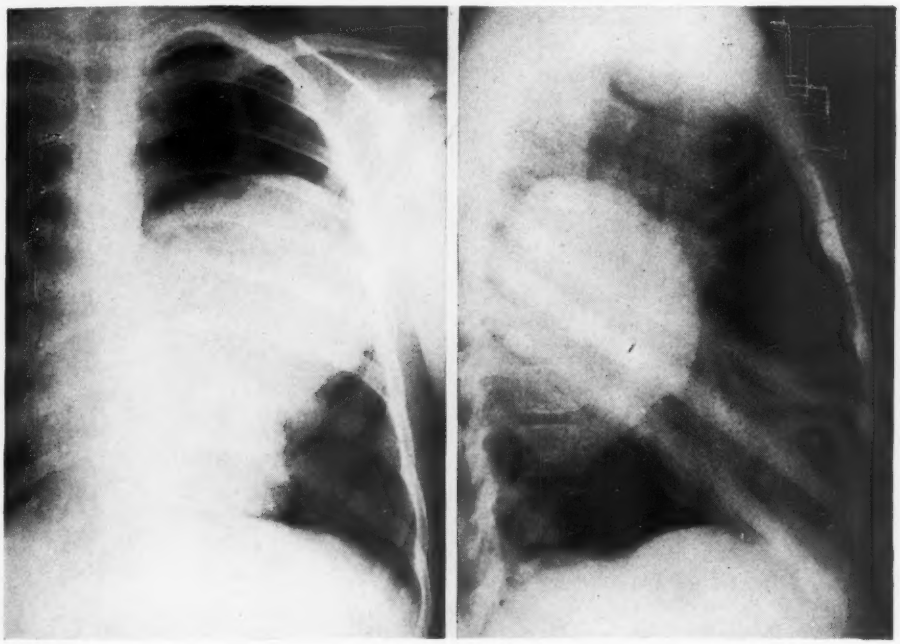

FIG. 2.—Reexamination following the creation of an artificial pneumothorax on the left. The air space beneath the capsule has disappeared.

tion one week later, following the production of a diagnostic pneumothorax, the air beneath the capsule was no longer seen (Fig. 2). The mass appeared to be separated from the parietal pleura at the lateral chest wall. At a third study, immediately preceding the operation, the pneumothorax had disappeared and there was again no sign of a capsule or any other differentiating shadow within the mass.

Operation.—April 4, 1942: Dr. Clifford D. Benson and Dr. Grover C. Penberthy. The left pleural cavity was entered through a posterior approach after resecting a portion of the fifth and sixth ribs. The lower lobe, containing the mass, was adherent posterolaterally to the parietal pleura (Fig. 3). These adhesions were easily separated. On exploration, a cyst was found at the periphery of the lung completely surrounded by pulmonary tissue except in an area 4 x 3 cm. on the lateral side. At this point it seemed covered only by a thick membrane which was incised for 4 cm. The edges of the cut membrane were retracted and a thin, white-walled cyst was exposed (Fig. 4).

Film-like adhesions between the cyst and outer membrane were separated carefully, allowing the complete removal of the pulmonary cyst intact (Fig. 5).

After the cyst was enucleated, a small bronchial fistula was seen in the depth of the adventitial pouch (Fig. 6). The outer membrane was excised and the fistula and defect in the lower lobe were obliterated by suturing the pulmonary tissue in three layers with interrupted chromic catgut. A Pezzar catheter was inserted in the eighth interspace and connected to a tube under water to allow for any drainage of

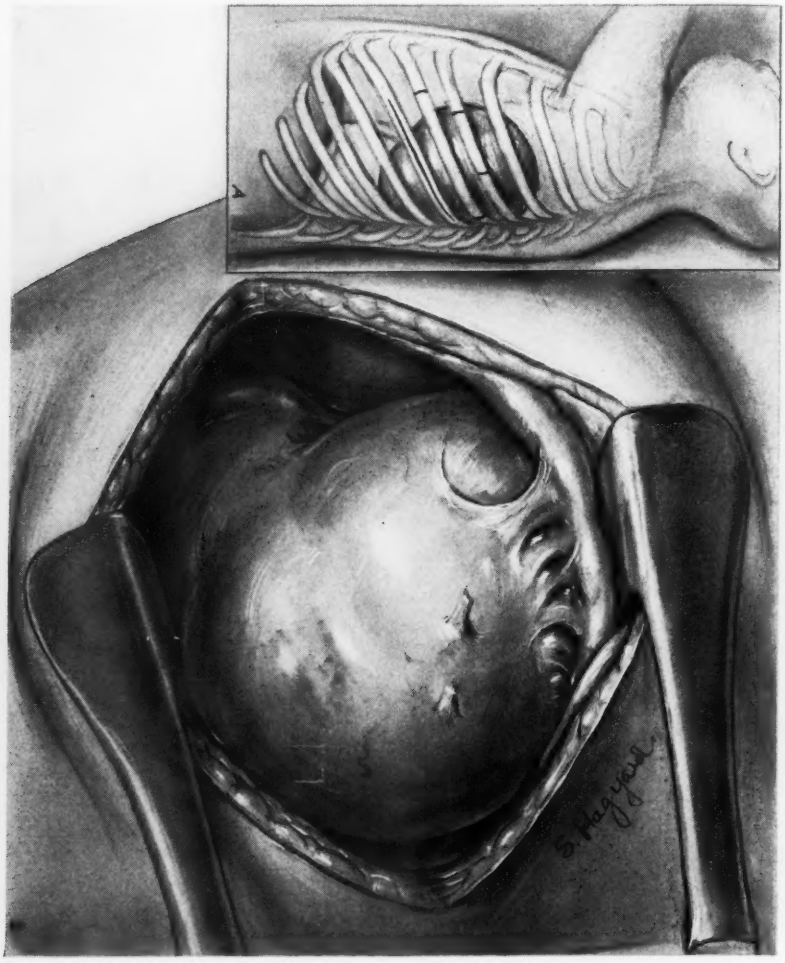

FIG. 3.—A. Demonstrates the surgical approach and relative position of the cystic mass. B. Operative sketch showing the left pleural cavity and cyst. Note the adhesions between the outer membrane and parietal pleura.

fluid or air. During the operative procedure the patient received 300 cc. of blood and 250 cc. of 5 per cent dextrose solution intravenously. The operative wound in the chest wall was closed in layers and healed *per primam*. The postoperative course was uneventful, with gradual complete reexpansion of the lung. The catheter was removed from the pleural cavity, May 6, 1942, and the patient discharged from the hospital in good condition May 8, 1942.

Pathologic Examination.—The material submitted for pathologic examination consisted of two specimens. One was a large thin-walled cyst of oval shape, measuring 10 x 8 x 8 cm. (Fig. 5). The outer cyst wall was fairly smooth except for a few thin tags and strands. The cyst wall was translucent and of jelly-like consistency. Within a few minutes after removal the cyst ruptured spontaneously, discharging approximately 200 cc. of a clear fluid containing a heavy, turbid, whitish sediment which settled rapidly. The inner surface of the cyst wall was finely granular. The fluid had a spe-

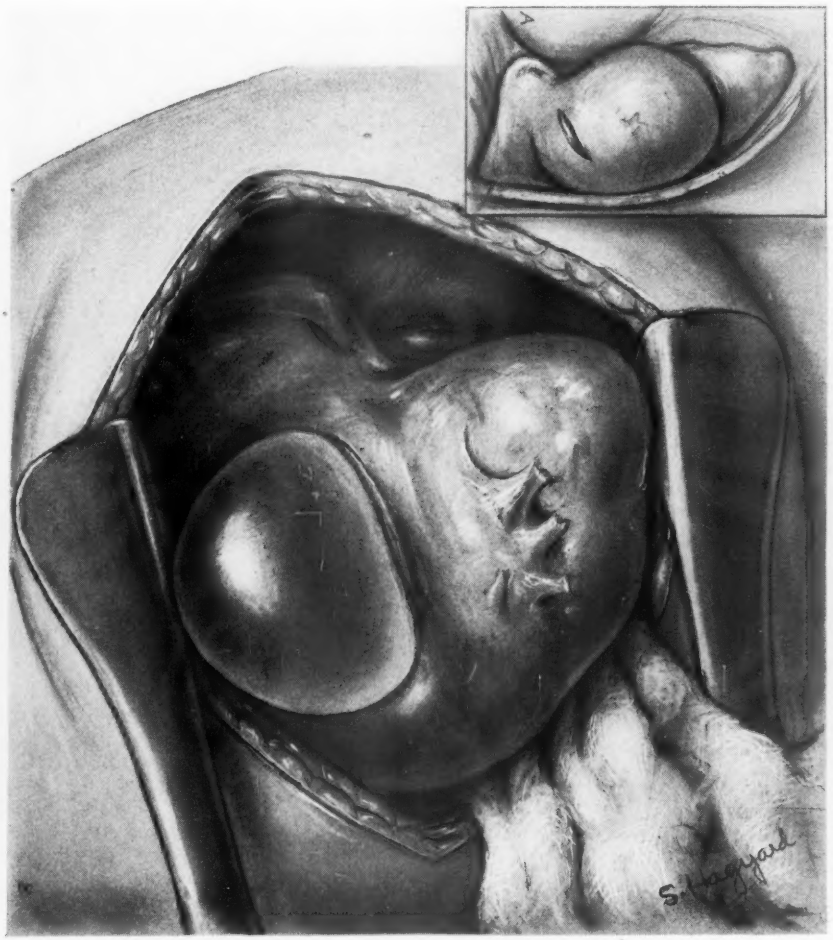

FIG. 4.—A. The outer membrane has been incised exposing the thin white membrane of the cyst proper. B. Demonstrates the echinococcus cyst being removed from within the outer membrane.

cific gravity of 1.012, and a weakly alkaline reaction. It contained no sugar and only a faint trace of albumin (probably due to contamination with blood from a piece of rib contained in the same jar). The sediment was loaded with well preserved scolices having the characteristic appearance of Taenia echinococcus (Fig. 7). The rostellum was usually inverted, occasionally everted, with distinct suction cups. In a few instances there was beginning segmentation. Here and there free hooklets were found. Microscopic examination revealed a thin, wrinkled, structureless membrane, with a loose cellular

inner layer lined with a sort of basement membrane. On thin projections of this membrane the scolices were attached, like wine glasses on their stems.

The second specimen consisted of a tough, firm, grayish-pink membrane, measuring 11 x 7 cm., varying in thickness from 0.1 to 0.4 cm. Both surfaces were rough and shaggy, and soft hemorrhagic thickenings were present on one side.

On microscopic examination the surface of this outer membrane facing the cyst was composed of dense acellular fibers of collagen. Farther outward this membrane became slightly cellular and was loosely infiltrated with plasma cells, lymphocytes and occasional eosinophilic leukocytes. There were a few capillaries in this region and occasional cleft-like compressed spaces lined with cuboidal or columnar epithelium resembling the lining of bronchioles. In a few areas the fibrous tissue of the membrane divided into two layers enclosing compressed, atelectatic alveoli. In several sections

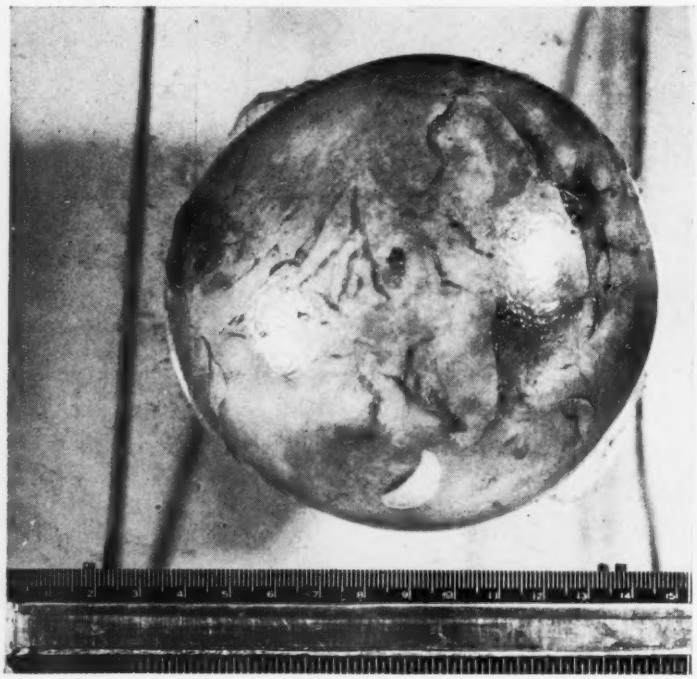

FIG. 5.—Photograph of the intact cyst after removal.

the membrane had no outer limiting layer. In one section, however, lung tissue was attached to the outer surface of the fibrous membrane. The lumen of the alveoli was for the most part considerably reduced and there was fresh hemorrhage into many air sacs, probably incidental to the operative procedure. The pleural surface of the lung was included on the side opposite the fibrous membrane. The pleura was thickened by fibrous tissue and in some areas there was considerable hemorrhage and exudation of fibrin on the mesothelial surface. Underneath the surface the mesothelial cells had proliferated.

DISCUSSION

Pathologic Aspects.—The cyst was a typical hydatid echinococcus. The thin-walled cystic mass first removed was the parasite itself. The delicate friable walls represented the so-called brood membrane of the parasite proper

to which numerous living scolices were attached. The fluid had the characteristics of echinococcus fluid and contained large numbers of free living scolices. The tough outer membrane, the adventitia, was formed by compressed, condensed and collagenized lung tissue with an inflammatory reaction. The surrounding alveoli were atelectatic and there was an acute and chronic pleurisy in the overlying pleura. All these features were entirely characteristic of a hydatid Taenia echinococcus developing in the lung.

FIG. 6.—Drawing of the outer membrane remaining after removal of the cyst showing the small bronchial fistula.

Surgical Aspects.—An excellent review of the history and development of the surgical treatment of pulmonary echinococcus cysts has recently been published in English by Arce.[3] In the light of this material, the case we are reporting is of unusual interest in that it was possible to remove the entire intrapulmonary cyst *intact*. Furthermore, the fistulous communication between a bronchus and the pericystic space beneath the adventitia, which accounted for the crescentic air chamber observed radiographically, was clearly demonstrated. Finally, the bronchial fistula remained closed after the surgical repair of the pulmonary defect incident to removal of the cyst.

Radiologic Aspects.—Echinococcus cysts of the lung, during the course

of their development and disintegration, exhibit an interesting variety of radiographic manifestations some of which are quite pathognomonic. The description of the radiographic appearance of pulmonary echinococcus disease goes back at least as far as 1899, when Levy-Dorn and Zadek[1] reported a case and differentiated between the simple unruptured cyst and one which had been evacuated. The classic description of a simple echinococcus cyst as a rounded shadow of uniform density and sharp outline in the clear pulmonary field is usually ascribed to M. A. Béclère (1903),[2] who considered

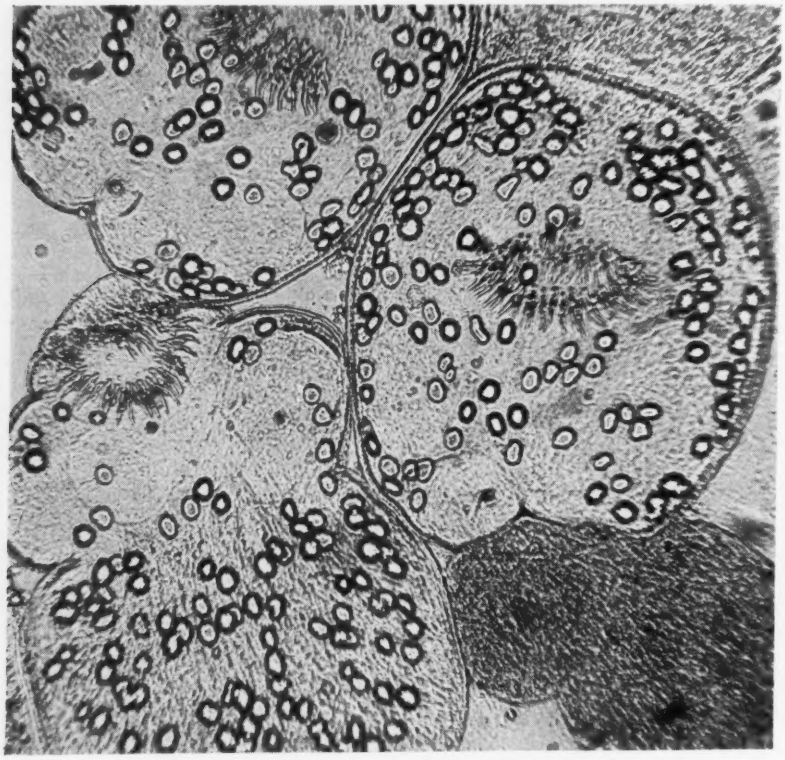

FIG. 7.—Photomicrograph of scolices obtained from the cystic fluid.

this picture as pathognomonic. However, in this stage of development of the cyst a positive radiologic diagnosis cannot be made, for differentiation may be impossible from neoplasms such as sarcomata, either primary or secondary, and occasionally chondromata and osteomata as well as carcinomata, neurinomata and fibromata. Rarely, certain inflammatory granulomata, such as the gumma of syphilis, dermoids and other congenital cysts, lymphogranulomata and even aneurysms may produce a similar appearance.

As the echinococcus cyst increases in size, the circular contour may be deformed through the resistance offered by the chest wall, the diaphragm or the bronchi. Escudero and later Nemenov[4] observed that hydatid cysts in contrast to solid tumors may change their shape during respiration and

this manifestation is known as the sign of Escudero-Nemenov. Large cysts tend to produce an enlargement of that portion of the thorax in which they lie with displacement of the mediastinal structures to the opposite side. This behavior is in contrast to that of tumors which are more apt to produce massive atelectasis and contraction of the chest and is referred to as the sign of Querilo-Walsch. Cysts, in contrast to aneurysms, do not produce erosion of bone. The outline of the cyst is not always sharp and particularly in older cysts there may be varying degrees of inflammation and atelectasis in the lung adjacent to the adventitia of the cyst giving an indistinct feathered outline. If the pleura is near the cyst a marked pleural reaction may develop. Although the adventitia may become very dense and sclerotic it rarely becomes calcified, in contrast to hepatic hydatids.

As the cyst enlarges bronchial communication may develop in the adventitia and upon coughing or other forceful expiration a small amount of air may enter the space between the membrane of the hydatid vesicle which is part of the parasite proper and the adventitia which is formed by the host. Like the pleural space, this space is originally present as a virtual one only. According to Dévé,[5] the great French authority on echinococcus disease, this manifestation of air between the membranes was first observed radiographically by Zehbe,[6] in 1916. It was subsequently described by others but its significance and diagnostic importance was not appreciated until interest was aroused by the reports of Caeriro and Goyena,[7] of Buenos Aires, in 1933, and independently by Morquio, Bonaba, and Soto,[8] of Montevideo, in 1934. The latter group, which had observed five cases in about two years, gave the designation perivesicular pneumocyst to the phenomenon, and recognized that it was reversible. The parasite remains intact, with no escape or alteration of the contents of the cyst fluid. Belot and Peuteuil[9] reported the condition from Algiers, in 1936, as the "sign of detachment," and there were other reports from Nguyen-Dinh-Hoang,[10] Constantini and LeGénissel,[11] Guarini,[12] Ivanissevich and Ferrari,[13] Cantonnet Blanch, Charbone, and Barberousse,[14] Chifflet and Purriel,[15] Brun, Jaubert de Beaujeu and Bège,[16] Andrade,[17] Rivas and Gobich,[18] and others. Ivanissevich and Ferrari[13] were able to produce the condition experimentally by insufflating the trachea of a sheep affected with pulmonary echinococcosis. Chifflet and Purriel[15] observed that the sign may be brought out only on deep inspiration. Other terms used for the phenomenon are *càmara aerea* or air chamber, *calotte aerienne* or air cap, crescent image, periparasitic emphysema, pneumoperihydatid and pericystic emphysema. The phenomenon is generally regarded as a rare manifestation of pulmonary echinococcus but quite pathognomonic when it does occur. Constantini and LeGénissel[11] found it in only three of 100 cases reviewed by them. Dévé[5] observed a similar picture in a case of aspergillosis in which a mass of fungi, a mycelial calculus, almost filled a large bronchiectatic abscess, leaving only a thin layer of air. The mass however did not have the hair-line sharpness of a hydatid vesicle, and he regarded his case as "an

exception which proved the rule" concerning the pathognomonic validity of the sign.

Although the phenomenon of pericystic air space is reversible, it usually indicates the imminent disintegration and rupture of the vesicle and the subsequent evacuation of the cystic fluid and membranes through a bronchus ("vomica"). This is well illustrated in the serial studies of cases reported by Constantini and LeGénissel.[11] Presumably the detachment of the cyst results in impaired nutrition leading to the death of the parasite. As the fluid escapes from the cyst a fluid level is formed in the pericystic space and the brood membrane falls away from the adventitia and is recognized in the radiogram as an arch between the adventitia and the fluid level. This stage was first described by Cumbo, in 1921, hence known as Cumbo's sign, later by Tillier,[19] in 1932, Blefari-Melazzi,[20] in 1933, and by Ivanissevich and Ferrari[13] who referred to the roentgen appearance as the "double arc sign." Rivas and Gobich[18] observed the "double arc sign" three times in 150 cases encountered over a period of about 20 years.

When the cyst ruptures the fluid becomes infected, and the term pyopneumocyst is commonly used. As the vesicular membrane collapses further it becomes an irregular mass floating on the fluid. This produces the "sign of the *camalote*" (a South American river weed of the family of the Iridaceae, resembling a water lily) described by Segers[21] and Lagos Garcia, in 1924. Differentiation from the common pyogenic lung abscess may be difficult at this stage. According to Tillier[19] the recognition of the retained membrane and the slow movement of the fluid on change of position, which is due to the presence of the membrane rather than actual viscosity of the fluid, permit the diagnosis of echinococcus disease. A final manifestation is the expectoration of the cystic fluid and fragments of the membrane. The diagnosis can then be made upon identification of the hooklets or the membrane. The entire parasite may be evacuated in this manner and a spontaneous cure result.

SUMMARY

Successful surgical excision of an echinococcus cyst of the lung by a single-stage procedure is reported. The radiologic manifestation due to the presence of air between the parasite and the adventitia was present. A small bronchial fistula accounting for the latter phenomenon was demonstrated at operation. The recognition of this radiologic sign will lead to early diagnosis of hydatid cyst of the lung and, if followed by surgical excision of the cyst intact, will eliminate complications due to the rupture of the cyst and multiple-stage operative procedures in an attempt to cure the disease.

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EVOLUTION OF SPINAL FUSION

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Discussion of the evolution of spinal fusion must necessarily begin with the names of Russell Hibbs and Fred Albee, as these two men were the first to develop methods of spinal arthrodesis and to further the general use of these procedures by the orthopedic surgeon. Hibbs, in 1910, devised a method of using fragments from the spinous processes and laminae as a means of obtaining bony ankylosis, whereas Albee used a graft of free bone from the tibia of the patient. Hibbs had observed, in studying the pathology of tuberculosis of the spine after treatment with plaster encasements or braces, that in many cases a spontaneous bony ankylosis of the lateral articulations and occasionally of the laminae and spinous processes had occurred. Sometimes even the vertebral bodies were found to be fused together. He observed, also, that this natural ankylosis was usually incomplete, sometimes including the joint on only one side, and usually lagging behind the tuberculosis as it advanced up and down the spinal column. He found that it took many years for the ankylosis to occur, and that it rarely resulted in complete healing of the disease. Hibbs reasoned that if the ankylosis could be produced operatively, safely, and more quickly than would occur by the natural process, that the complete splinting effect afforded thereby might result in more rapid and more certain healing of the disease. He stated: "One of the reasons why the disease is so persistent in its destructive effect on the bodies of the vertebrae is because of the motion which takes place between them, and while the various methods of treatment limit the motion, none absolutely prevents it. In the light of our present knowledge and experience the greatest need in the treatment of this disease, both from the standpoint of shortening its duration and preventing its deformity, is the perfection of a method which will absolutely immobilize the spine throughout the diseased area and make development of deformity impossible. The writer has done an operation for stiffening the knee joint[1] . . . ", which "led to the conception if the periosteum of the spinous processes was carefully removed, and the processes were divided at their bases, and placed longitudinally in the interspinous space touching with either end the base from which the processes were removed and then the periosteum brought back and sutured, a similar condition would be produced."[2] On January 9, 1911, after preliminary work on the cadaver, with the assistance and encouragement of George Huntington, of the Department of Anatomy of Columbia University, Hibbs performed the first spinal fusion on a living subject, a boy with tuberculosis of the spine. The

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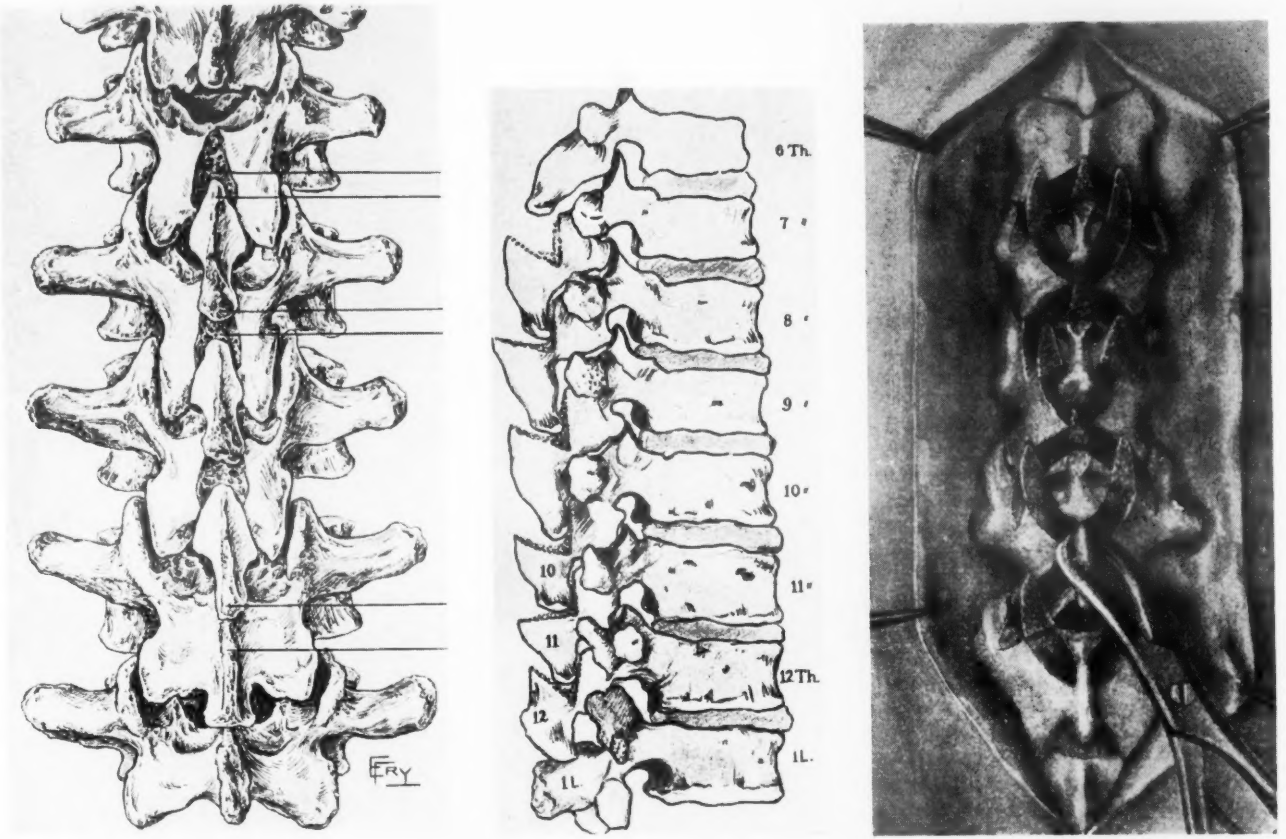


A B C

FIG. 1.—A. Original illustration used by R. A. Hibbs[2] in describing the first fusion operation (May, 1911). B. Illustration used in description of the operation including the use of chips from the laminae[4, 4a] (May, 1912). C. Hibb's[2a] illustration showing extended use of the fragments from the laminae and curettage of the lateral articulations (January, 1924).

patient recovered from the operation without complication, bony ankylosis occurred, and, over a period of months, the tuberculous lesion healed. Hibbs reported the operation on this and two other patients on May 27, 1911—"An Operation for Progressive Spinal Deformities[2]" (Fig. 1A). In this report he added: ". . . In the very young, however, I think it will be necessary to graft bone from the leg. This is a perfectly practical procedure." Further, ". . . No case of lateral curvature has yet been done, but I propose to do exactly the same operation, and if it is not sufficient, to do an arthrodesis between the lateral processes.[2] We see from these quotations how complete was Hibbs' conception of the principles involved.

In September of the same year, Albee[3] reported three cases which he had treated in June and July by the use of a tibial graft implanted in the spinous processes. He stated: ". . . Previous to the herein reported cases, five patients were operated on and three or four spinous processes were split . . . and the tip of the lower half of the superior vertebra was then brought into approximation with the tip of the superior half of the next lower vertebra after green-stick fractures of each, and fastened with heavy kangaroo tendon. Chips of bone from the spinous processes were then placed in between so as to insure further bone union between these vertebrae. This union has been satisfactory so far as can be ascertained, but on account of its uncertainty and the large amount of cartilage in the vertebrae of small children, with its slowness of union and early lack of support, it has seemed best to devise a procedure which would be possibly more reliable and also give support from the beginning. These requirements can be fulfilled in no other way except by a strong bone graft. The different sources from which to secure a strong bone graft for an internal splint, which would give immediate support to the spine, were considered, and the crest of the tibia was selected as by far the most desirable and accessible."

Hibbs[4, 4a] operated upon 43 cases with tuberculosis of the spine in the first year. These cases were reported in April, 1912 (Fig. 1B), and at this time Hibbs mentioned an extension of the operative procedure, stating that: "The space between the laminae is bridged by elevating a small piece of bone from the edge of the lamina, and placing it transversely across, its free end in contact with the lamina next below, with the gap between the spinous processes filled by their transposition. This makes me doubt the necessity for suturing the periosteum as I think bone becomes continuous and that a fusion takes place of the vertebrae operated upon." He emphasized here the complete subperiosteal dissection of the spinous processes and laminae as far laterally as the bases of the transverse processes. He further mentions suturing the periosteum of the spinous processes together on each side to close the gap produced by the interspinous ligament but questions the necessity for this step. Farrell[5] reported many additional cases in January, 1915.

In June, 1917, Hibbs[6] reported eight cases in which the spinal fusion was used in scoliosis for the prevention of increasing deformity and improvement in the stability of the spine. The first of these operations was performed in 1914. We note here the application of the suggestion made by Hibbs, in 1911, regarding the treatment of the lateral articulations: "The first thing to be done is to curet the lateral articulations which lie at the base of the transverse processes and are easily reached in children and in most adults."

In June, 1918, Hibbs[7] reported 210 cases of spinal tuberculosis treated by the fusion operation, at which time he emphasized the use of special gauze packings to prevent bleeding and secure a clear field. Also, he pointed out that in the lumbar spine it was often desirable to split the spinous processes, turning portions of it upward and other portions downward, interdigitating these fragments. Fifty-nine fusion operations for scoliosis were reported[7a] in January, 1924, and the further development of the operation described (Fig. 1C). Thus we have the picture of the development of the fusion to include not only the spinous processes, but the laminae and lateral articulations, resulting in a solid mass of thick bone extending completely across the posterior surface of the spinal column.

This early period should not be dismissed without mention of several other attempts at internal fixation of the spine. Hadra,[8] in 1891, had wired together the spinous processes in treating fracture. Lange,[9] in 1902, had begun to use steel rods sutured in the angles between the spinous processes and the laminae, and subsequently he used celluloid cylinders in a similar manner. Reporting his early work at the meeting of the American Orthopedic Association in 1910, he stated: "We must work for two things in our treatment of these cases; first, we must put our braces under the skin, and second, we must shorten the time for recovery for our patients." DeQuervain and Hoessly,[10] in December, 1911, independently of a knowledge of Albee's work, reported the use of the spine of the scapula as a free graft into the split spinous processes. At the same time they reported an interesting series of experiments on dogs. Gallie,[11] in 1915, attempted arthrodesis by use of prepared beef bone grafts.

Despite the several technics described, this early period was marked not so much by study of the technic of spinal fusion, as by discussion as to whether spinal fusion was justified at all. As the operation was usually undertaken upon children, the possibility of interference with growth of the spine had to be considered as well as that of production of deformity by fusing only the posterior elements of the spine. Some orthopedists feared that fusion would stop the growth entirely, while others said that the vertebral bodies would continue to grow, while the fused posterior portion of the spine would remain stationary. The latter course would have been a desirable outcome in cases of tuberculosis as it would have caused the correction of the kyphosis, but unfortunately this did not occur. It was found, over a period of years, that growth of the spine continued at the

normal rate after fusion, and that the trunk-leg ratio remained the same in these patients as in normal individuals, allowing for the effect of the kyphos. No one knew whether the spines of very young children could be fused. This doubt was probably due to failure to realize that the spinous processes and laminae are ossified, even in the infant, although the lateral articulations and tips of the spinous processes are largely cartilaginous. The young spines did fuse, however, and a successful fusion was accomplished on one infant at the age of eleven months, probably the youngest ever attempted. Fusions were undertaken also for patients past the age of 60, again, with success.

The presence of tuberculosis in and around the laminae and articular processes presented another problem. The bone chips often failed to unite in the diseased area, and at times were even extruded, and sinuses developed, while the disease continued to advance. Furthermore, many of the patients of that day, long sufferers, with marked deformities, had developed amyloid disease, chronic sinuses, spastic paralysis or complications which produced an unfavorable general or local situation.

Many orthopedists feared that the traumatism of operation would stir up the disease and result in its spread as miliary tuberculosis or tuberculous meningitis. It was found, however, that the incidence of these complications was far less during the months following operation than it had been in the patients treated without operation. The operative mortality in the first 20 years of the operation was only 1.4 per cent, whereas 15 per cent of the patients died of pre-existing tuberculosis elsewhere in the body.

MODIFICATIONS

The second period in the evolution of spinal fusion may be characterized as one of modification. Perhaps the low mortality in cases described by Hibbs led to the impression that the operation was so simple that it could be learned through reading its description, or merely seeing it performed once. Lack of familiarity with the operation or lack of skill in its performance resulted in a high percentage of failure in the hands of some orthopedists, as a result of which the operation itself was in some quarters unqualifiedly condemned. Many of those who did not condemn or cease to employ the operation, sought to modify it for the sake of simplicity and reduction of the operative risk in their hands. The portion of the operation which seemed to give the most difficulty was the approach to and treatment of the lateral articulations. Forbes,[12] in 1920, omitting the inclusion of the lateral articulations in the fusion, split each spinous process and lamina into several fragments instead of two or three as Hibbs had been doing. Radulesco,[13] in 1921, reported a modification of the Albee procedure, in which half a rib, with periosteum attached, was used instead of a tibial graft. Brown,[14] and also Kleinberg,[15] in 1922, reported the use of beef bone grafts along with a partial fusion operation. Thomas,[16] in November, 1923, reported

the use of an osteoperiosteal graft and what he described as "wafer chips." Several operations extended the procedure beyond the posterior elements of the spine. Led by MacClennan,[17] who resected a portion of the vetrebral body for scoliosis, in 1922, and Royle,[18] who removed a hemivertebra in 1928, Ito[19] inserted bone grafts into slots in the vertebral bodies and reported a number of cases in 1934. Schede,[20] in 1925, used a graft as a prop between the ilium and transverse processes and props have even been used between the ilium and the ribs.

Most of these modifications were unnecessary, and some added an unjustifiable risk to the operation. The significant thing is that the spine was being fused. It matters not so much how a particular chip is laid or from whence a particular fragment of bone comes, but as to whether fusion is obtained, how quickly, and how strong.

APPLICATION TO OTHER CONDITIONS

A further development marked this second period—the application of the fusion to other conditions than tuberculosis and scoliosis. Hibbs,[21] in 1922, reported the use of the fusion in 22 cases of "fracture-dislocation of the spine," the cases dating from 1916. The first one of the series was an unrecognized instance of spondylolisthesis, and represents the first application of the procedure to this anomaly. At least eight additional cases in this group had spondylolisthesis, but there were also cases of compression fracture of the spine. The operation was also applied to the other lumbosacral anomalies,[22] such as the acute lumbosacral angle, posterior displacement of the fifth lumbar vertebra, transitional lumbosacral joints, and deformities of the lateral articulations. The first lumbosacral fusion for a mechanical condition was performed in October, 1914. It has also been employed in cases of round back, hemivertebra,[23] with or without partial resection, osteomyelitis,[24] occasionally in localized osteo-arthritis of traumatic origin, and, rarely, in other conditions. We have been doing the fusion in conjunction with removal of the ruptured nucleus pulposus since November, 1937.

OPERATIVE TECHNIC

The principle of the Hibbs operation has remained the same, but there have been several useful minor modifications. Hibbs devised a rasp which was driven into the lateral articulation for the purpose of scraping out the articular cartilage. It was found that even the rasp and curet usually did not effectively bare the articular surfaces. At the present time the articular cartilage with a little of the underlying cortical bone is removed with a straight osteotome or one especially angled for the purpose. Usually, the spinous process is removed and cut into long thin fragments which are eventually laid across the interlaminal spaces. If there is not sufficient bone at the site, as in some cases of spondylolisthesis or spina bifida, additional bone may be secured by removing neighboring spinous processes, or from the

region of the posterior superior iliac spine. The present procedure is, in general, as follows: A midline incision is made through the skin and subcutaneous tissue, and skin towels are applied with Michel clips. The deep fascia and supraspinous ligament are incised, and, with a Kermison elevator, the ligament is stripped from the tip of the spinous processes. The interspinous ligaments are incised longitudinally. The periosteum is carefully

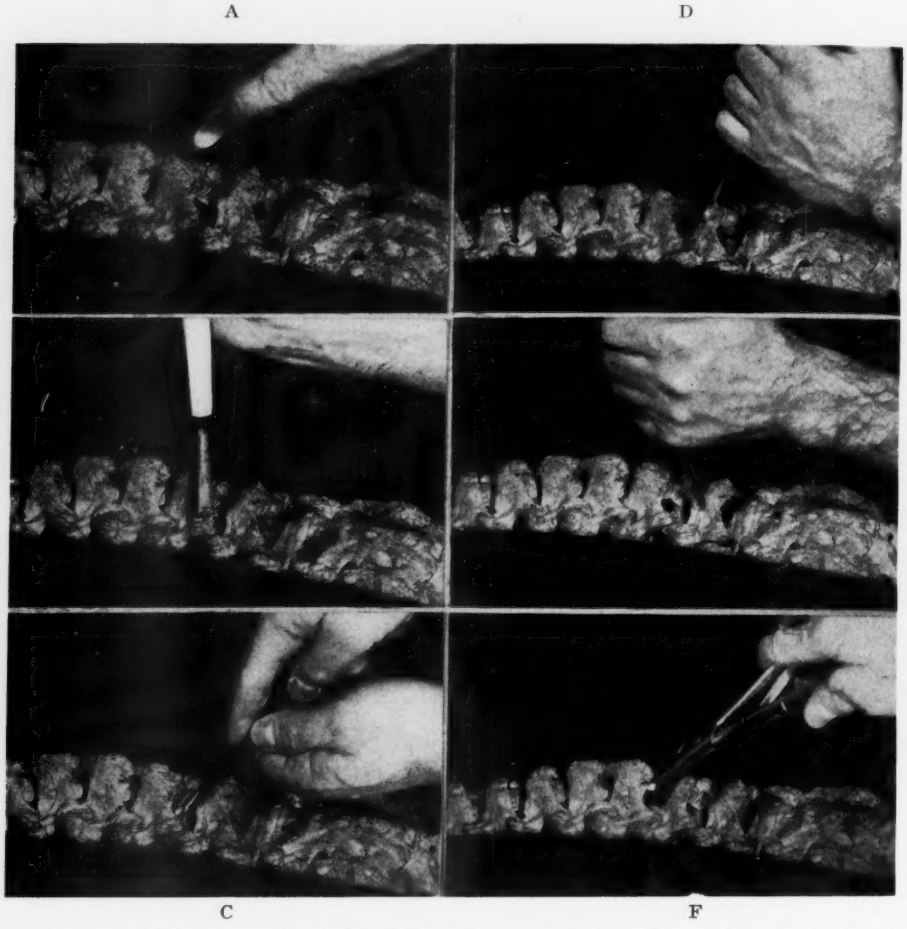
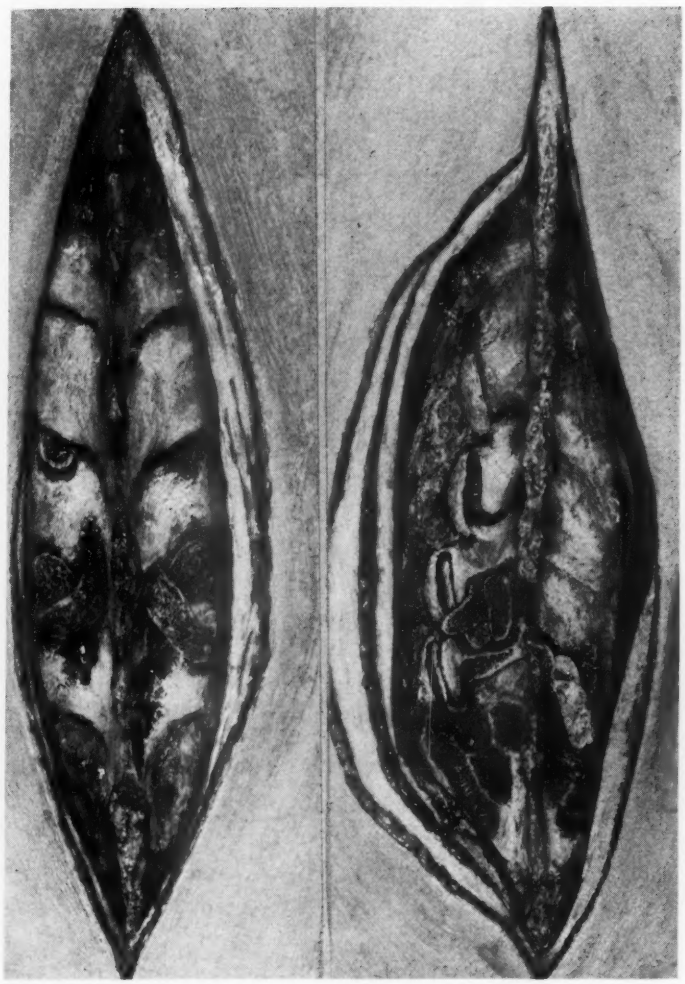


FIG. 2.—Technic of Spinal Fusion: A. Elevation of periosteum from spinous processes and laminae with Kermison and sharp, curved elevators. B. Completion of subperiosteal dissection and stripping of posterior capsules with "chisel" elevator. C. Dissection of interspinous ligament and posterior two-thirds of ligamentum flavum with curets, baring margins of the laminae and spinous processes. D. Excision of articular cartilage and subjacent cortical bone with straight or angled osteotome. E. Gouging of chips, into articular gap, subjacent fossae, and interlaminal spaces. The operation is completed by turning or placing the fragments from the spinous processes longitudinally from lamina to lamina. F. Removal of spinous processes. (This step is done in various ways and at various periods by different operators.)

stripped with sharp periosteal elevators from the spinous processes and laminae, far enough laterally to completely expose the lateral articulations (Fig. 2, A to F). This exposure is sharply limited, however, as there are usually blood vessels just beyond the lateral articulations which may be troublesome if opened. Further dissection may often be simplified by removal of



A B

FIG. 3.—Specimens showing successive stages of the spinal fusion operation. A. Thoracic Spine: Subperiosteal dissection of spinous processes and laminae; excision of interspinous ligaments and ligamentum flavum; excision of posterior articular capsules; excision of articular cartilage; insertion of bare chips in articular gap; chips turned across interlaminal spaces from laminae and spinous processes. B. Lumbar Spine: The same, showing also the spinous processes cut into several fragments and placed across the lumbosacral joint, on the right.

the spinous processes at this stage. An assistant can be detailed to cut them into proper fragments or they may be split longitudinally before their removal. Next, the ligamentum flavum is largely removed, leaving only a thin anterior layer. This may be done very simply with a sharp curet by cutting its attachment to the superior margin of the distal lamina, then cutting it from the inferior margin of the proximal lamina, which overhangs it, and peeling it away from its most anterior layer. It is quite important to carefully remove all the ligament from the little fossa subjacent to each lateral articulation. The articulation is then denuded of cartilage and cortical bone with

osteotome and curet, with particular care to include all of the articular surface in the cup-shaped or oblique articulations, but to avoid penetration of the instruments or fragments of cartilage into the intervertebral foramen. A small fragment of bone is turned up with a gouge and jammed into the gap between the articular processes, and the whole fossa is bared of cortical bone by gouging up successive small chips which are locked together to form a small compact mass filling the fossa. Some operators prefer simply to insert a fragment of bone from the spinous process into the interarticular gap and do not thoroughly denude the articular cartilage or the fossa, which we consider the most crucial point in the fusion. Next, chips are cut with the gouge from the laminae and turned across the interlaminal spaces, interdigitating, and left attached at their bases as much as possible. Then the longer fragments from the spinous processes are laid longitudinally across the interlaminal space (Fig. 3 A and B). If the chips are simply dumped in like jackstraws, to lie in any direction and any location, the chances of pseudarthrosis are greatly increased. The careful placement of these chips is of greatest importance.

Finally, closure is made carefully and in anatomic layers. The periosteum and muscles are snugly sutured over the chips so as to obliterate any potential dead space, which might permit a large hematoma and allow displacement of the chips. The interspinous and supraspinous ligaments are then sutured, and finally the fascia and subcutaneous tissue, and the skin.

POSTOPERATIVE CARE

The postoperative care depends somewhat upon the condition for which the operation is undertaken. The general care of the patient is important, including adequate calcium and phosphorus, vitamins, and transfusions or iron if anemia is present. The chief feature of postoperative care is proper immobilization of the spine by bed rest and a brace or plaster jacket until the fusion has become sufficiently strong to support the weight of the trunk, and ordinary body movements. The patient is placed on a bed with a firm mattress and fracture board. Those with scoliosis are operated upon through a fenestrated plaster jacket, and the jacket is then reinforced. Other cases have a Taylor brace applied. Turning by the nurse is permitted, on the side, prone or supine, usually on a four-hour schedule. The patient is turned in such a way as to move the trunk *en masse*. Patients with a simple lumbosacral anomaly or compression fracture are kept in bed for about six weeks and wear the brace for a total of four months. Patients with spondylolisthesis, scoliosis, or tuberculosis remain in bed about 12 weeks. Those with scoliosis wear a jacket for an additional three to six months, while the others wear a brace for a somewhat shorter period. These patients return to their regular activities within three months to one year following operation, depending upon the original condition, the progress of the fusion, and the character of the patient's activities.

COMPLICATIONS

It is to be expected that there will be an occasional failure of fusion, just as there are failures of union in the treatment of fractures, in osteotomies, and in bone grafts. However, these failures should be minimal and it should be realized and admitted that if they represent any appreciable percentage of the total number of cases, they must be ascribed to the technic of the operation and the postoperative immobilization. For example, during the five years 1931 to 1935, inclusive, more than 600 spinal fusions were done for all causes at the New York Orthopaedic Hospital. These operations were performed by the House Staff, Fellows, and Attending Surgeons. One or more psuedo-arthroses occurred in 14 per cent of the cases, nearly all of which were subsequently repaired. The largest number of failures, 18 per cent, was found in the group of spondylolistheses, while the lumbosacral fusions failed in only eight per cent, and in the fracture cases—none. It has been repeatedly demonstrated by clinical examination and roentgenograms, by subsequent operations, and occasionally by necropsy, that fusion can be accomplished in a large percentage of cases. It is futile, at the present time, to ascribe failures to the patient's "refusal to grow bone," or to the character of the operation. The operative mortality in more than 3,000 fusions at the New York Orthopaedic Hospital during the period 1911 through 1937 has been 0.6 per cent, whereas there has been no death from the operation since March, 1935. Thus, it is seen that the operation need not carry an appreciable risk to the life of the patient.

INDICATIONS

The indications for the operation may be summarized as follows, assuming a surgeon capable of properly performing the operation and an institution suitable for the care of the patient:

1. Tuberculosis: The treatment of choice at all ages, unless complete spontaneous natural fusion can be demonstrated, or the general condition of the patient or complications preclude the operation.

2. Scoliosis: In children with rapidly progressive deformity, or deformity with decompensation which can be corrected sufficiently to warrant fixation; in adults, occasionally for relief of pain.

3. Spondylolisthesis: All cases in the lower lumbar region unless contraindicated by age or the general condition of the patient.

4. Other lumbosacral anomalies: Pain of long duration, of moderate or great intensity, frankly due to the anomaly and unrelieved by other treatment.

5. Rupture of nucleus pulposus: Many of these joints are unstable primarily, and should be fused upon removal of the nucleus, preferably without laminectomy.

6. Compression fracture of the spine and some dislocations: As a means of maintaining reduction, hastening convalescence, and preventing pain.

7. With laminectomy: When indicated with a coincident orthopedic condition, or an extensive procedure.

8. Special indications in certain other conditions.

CONCLUSIONS

The effects of the operation should be clearly understood. A fusion may hasten and assure healing of tuberculosis and perhaps sometimes other infections, by completely immobilizing the diseased section of the spine. Progressive deformity due to tuberculosis, scoliosis, and spondylolisthesis may be prevented. The establishment of fusion for this purpose in cases of round back or hemivertebrae is open to question. In scoliosis and fracture, fusion may be the best or only means of maintaining correction of deformity. We do not attempt, and advise against, attempting to correct the deformity in tuberculosis. Fusion may be used for the relief of pain in the lumbosacral anomalies as well as all of the conditions just named. In many cases it may not only aid in the cure of the disease, the arrest or correction of deformity, and the relief of pain, but may be the quickest and most economical method of relief, in this way offering a financial advantage to both patient, hospital, and community. Thus, we see that spinal fusion has evolved during the past 30 years from a "radical" procedure in the treatment of tuberculosis, to a well established operation employed for a number of abnormalities of the spine. It is not a panacea, but in properly selected cases, and in skilled hands, fusion offers little risk and the possibility of great benefit to a large number of patients.

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STENOSING TENDOVAGINITIS AT THE RADIAL STYLOID (DEQUERVAIN'S DISEASE)

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THE PURPOSE OF THIS PAPER is to call attention to the existence of a relatively common and extremely disabling condition, first described in 1895 by Fritz DeQuervain. My interest was aroused when, some five years ago, I encountered my first case of stenosing tendovaginitis at the radial styloid. In speaking to other surgeons of this condition I have been surprised to find that many were unaware of its existence. No credit is claimed for original observations, but it is felt that a useful purpose can be served by once again presenting the facts and thereby drawing attention to a disease entity which it seems is frequently overlooked.

DeQuervain's original article,[1] paints the picture so clearly that I shall quote from it at some length: "Although chronic disease involving tendon sheaths is most frequently construed as tuberculosis, there are types which neither from the clinical picture nor from the anatomic findings should be placed in this category. Among these may be mentioned tendovaginitis chronica sicca, tendovaginitis prolifera urica, and serous nontuberculous tendovaginitis. Chronic nontuberculous tendovaginitis has seldom called for surgical intervention, and is mentioned in most textbooks briefly, if at all. It, therefore, seems proper to discuss a condition which, although still belonging to the first type, tendovaginitis sicca, deviates in some important respects from the exact picture and in which surgical treatment has proved extremely beneficial. Through the kindness of Dr. Theodor Kocher I was given the opportunity to observe and to operate upon my first case when I was his assistant in the Surgical Clinic in Bern. Frau L., who occupied herself with housekeeping and woodgathering, noticed, in October, 1893, that the moving of her right thumb had gradually become painful. The pain was localized chiefly over the distal end of the radius and radiated up the forearm. The pain was sometimes so severe that she was unable to make grasping motions. There had been no swelling or other signs of inflammation. Despite massage with spirits of camphor and the application of heat, the pain had increased so that, in February, 1894, she came to the Surgical Clinic. The findings at her first visit were as follows: There was no sign of tuberculosis, syphilis or gout in the entire body. Motion of the right thumb was painful. Palpation revealed a slight thickening over the common sheath of the extensor pollicis brevis and abductor longus muscles. This sheath was keenly sensitive to pressure. There was no crepitation. It appeared that the condition might well result from a thickening of the sheath of the extensor pollicis brevis and abductor longus tendons, firmly encased as it is by the fibers of the dorsal carpal limament, and that the functional

disturbances were due to increased friction in this region. Assuming a stenosis of the sheath, on March 7, 1894, under cocaine anesthesia, I removed the common sheath of the extensor brevis pollicis and abductor longus. The sheath was slightly thickened. Otherwise it appeared normal, as did the bone. Following operation there was no further pain and full use of the thumb returned in a few days. A report, March 7, 1895, stated that the patient had remained completely cured." DeQuervain described four similar cases, all promptly relieved by operation.

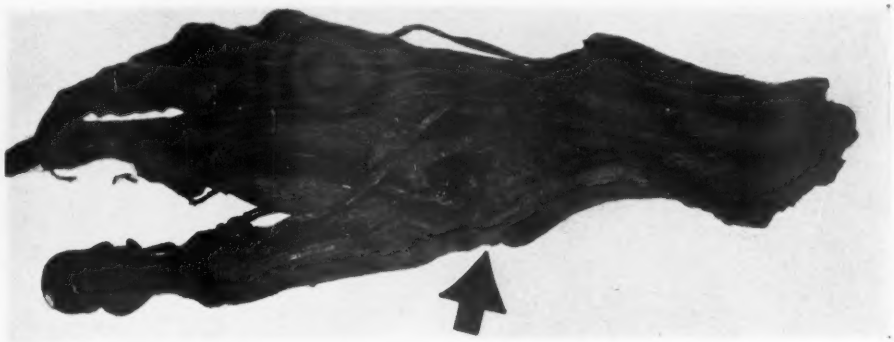

FIG. 1.—Shows the tendons of the abductor longus and extensor brevis pollicis passing upward beneath the dorsal carpal ligament. It is this portion of the ligament which is divided at operation.

DeQuervain's disease first appeared in American literature in 1927, in an article by Stein.[2] He reported five cases and described a similar condition involving the tendon of the extensor carpi ulnaris which passes through the fifth radial compartment. In 1928, Schneider[3] reported 15 cases of his own, and referred to an article by Alfons Eschle, of Basle, who, in 1924, collected 110 cases from the foreign literature, to which he added 19 personal cases. In 133 of these cases, where the sex was known, there were 119 females and 14 males. In 1930, Finkelstein[4] reviewed the subject thoroughly and added 32 cases from the Hospital for Joint Diseases. In 1935, W. M. Brown[5] reported the first case to appear in the British literature. This patient was cured after 18 weeks in plaster. This was followed, in 1936, by an article by Burns and Ellis[6] in the Lancet. They reported 28 personal cases. In the same year, Patterson[7] reported six cases from the Bridgeport Hospital. In 1938, Keyes[8] read an excellent paper before the Surgical Section of the New York Academy of Medicine. He reported one personal case, and referred to a second, a patient of another surgeon. This was an anesthetist who contracted the disease in his left hand as the result of gripping an ether mask for long periods of time. He continued his work while under treatment and within a short time the right hand became involved. In 1938, an article by Cotton, Morrison and Bradford[9] appeared, and in the following year a report by Diack and Trommald.[10] In 1941, C. F. Wood[11] stated that in a careful review of the literature he had been able to find 250 cases reported up to the year 1938. Inasmuch as some

confusion exists in regard to so-called "snapping finger" (*doigt à ressort*) and true stenosing tendovaginitis, I shall include two excellent references which fully describe the former condition—Compere,[12] and Zelle and Schnepp.[13]

The tendons of the abductor longus and extensor brevis pollicis pass through a shallow groove on the outer surface of the styloid process of the radius. The tendons at this point have a definite sheath which is in close contact with the dense fibers of the dorsal carpal ligament (Fig. 1). If the interphalangeal joint is flexed and the thumb actively abducted and drawn toward the ulnar side it will be noted that the tendons of the abductor longus and extensor brevis pollicis, while lying parallel in the groove of the radius, thereafter promptly diverge toward their insertions, the base of the metacarpal and the base of the proximal phalanx of the thumb respectively (Fig. 2). It will likewise be noted that in full abduction these tendons exert a considerable pull on the distal end of the radial compartment, and that the direction of this pull is at right angles to the long axis of this compartment. The tendon sheath is thus squeezed between the dorsal surfaces of the tendons and the dorsal ligament.

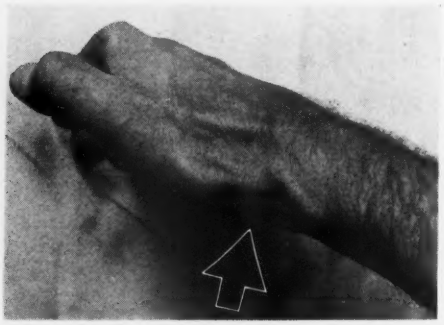

FIG. 2.—Shows the tendons of the abductor longus and extensor brevis pollicis. It will be seen that these tendons come together at an angle to pass upward beneath the ligament.

The exciting cause may be acute trauma. More frequently DeQuervain's disease is the result of sustained or oft repeated active adduction from a position of the extreme abduction.* The pathology found at operation varies. Most authors agree that there is a thickening of the sheath and of the overlying dorsal ligament, with a resulting constriction of the tendons. In some cases there have been signs of inflammation, as evidenced by the presence of fluid within the sheath and by a roughening of the tendon surfaces. In the writer's cases the outstanding finding was a marked thickening of that portion of the dorsal carpal ligament which overlies the sheath. This thickening decreased the diameter of the canal to such a degree as to interfere with the smooth action of the enclosed tendons. In one case there was a localized thickening of the ligament which had resulted in an hour-glass deformity of the tendons. It is possible that the primary pathology may well be limited to the dorsal ligament and that the variations from the normal which are encountered in the sheath and tendons are secondary to this. Sections

*Although the writer has not seen a report of stenosing tendovaginitis resulting from the operation of firearms, the causative factor is present in the handling of a gun over a prolonged period of time.

of excised ligaments have shown dense fibrous tissue with sometimes a mild degree of round cell infiltration.

The diagnosis is not difficult. The chief complaint is pain on moving the thumb. There is often a definite history of chronic trauma—bottle corking, piano playing, crocheting, boxing, and, in one of my cases, the holding of an artist's palette for hours at a time. There may or may not

FIG. 3.—Shows deformity of right wrist caused by thickening of the dorsal carpal ligament. This is not a constant finding.

be discernible swelling in the region of the canal (Fig. 3). There is acute tenderness over the radial styloid. An excellent diagnostic sign, as pointed out by Finkelstein, is the following: The patient's thumb is placed in the hollow of the palm and grasped by the remaining fingers (Fig. 4). With the hand in this position even slight forced ulnar deviation at the wrist will produce excruciating pain. Roentgenograms are universally negative. Under differential diagnosis must be mentioned old fracture of the carpal scaphoid, fibrinous tenosynovitis involving the sheath of the extensor longus pollicis, rheumatoid and gonorrheal arthritis, "snapping finger," and sprain of the internal lateral ligament of the wrist joint.

Treatment consists in longitudinal division of that portion of the dorsal carpal ligament which overlies the sheath. This will in all probability be sufficient. In some cases which have been reported it has seemed wise to excise portions of the ligament or the sheath, or both. A few cures following conservative treatment (plaster of paris for from 6 to 18 weeks) have been

reported. Many have been treated conservatively, to no avail, and have subsequently been operated upon.

The technic is as follows: Under novocain anesthesia, and with or without a tourniquet applied to the upper arm, a longitudinal incision, one and one-quarter inches in length, is made. The lower end of this incision corresponds to the proximal and radial angle of the anatomical snuff box, and

FIG. 4.—In stenosing tendovaginitis even slight, forced ulnar deviation with the hand in this position causes extreme pain.

is continued upward just to the ulnar side of the tendon of the flexor brevis pollicis. A small branch of the radial nerve and a vein, which cross the line of incision, must be recognized and avoided. A transverse incision may be employed at the level of the styloid process. This will result in a less noticeable scar, but care must be taken not to injure the radial artery. The dorsal ligament lies directly beneath the subcutaneous fat and that portion which covers the sheath is easily recognized when the thumb is forcibly abducted. The ligament is divided from above downward. This may be done by inserting the point of a No. 11 Bard-Parker blade beneath the upper edge of the ligament and cutting distally with the sharp edge away from the tendons. The contents of the canal can now be examined and, if thought necessary, a portion of the ligament, sheath, or both, can be excised. The superficial fascia is closed with fine silk or plain catgut and the skin with interrupted fine silk. It has been my custom to apply a light

basswood splint to be left in place for two or three days. This not only minimizes discomfort but hastens healing and is a safeguard against infection.

During the past five years I have operated upon eight cases of DeQuervain's disease, six at the Doctors' Hospital and two at Bellevue Hospital.

ABBREVIATED CASE REPORTS

Case 1.—Z. H. T. A woman, age 65. Duration of symptoms—six months. Causative factor—crocheting. Typical signs. X-ray negative. Operation May 25, 1937. Pathology—localized thickening of dorsal ligament at its center, producing hourglass constriction of tendons at that point. Sheath thickened. Procedure—division of dorsal ligament.

Case 2.—J. H. A man, age 28. Duration of symptoms—three months. Causative factor—boxing. Typical signs. X-ray negative. Operation January 21, 1938. Pathology—thickening distal half of dorsal ligament. Slight thickening of sheath. Tendons normal. Procedure—division of dorsal ligament.

Case 3.—F. S. A woman, age 67. Duration of symptoms—three weeks. Causative factor—holding painter's palette for long periods of time. Typical signs. X-ray negative. Operation October 16, 1939. Pathology—diffuse thickening of dorsal ligament with thickening of sheath. Procedure—division of dorsal ligament.

Case 4.—L. P. A woman, age 38. Duration of symptoms—three months. Causative factor—undetermined. Typical signs. X-ray negative. Operation November 8, 1939. Pathology—diffuse thickening of dorsal ligament. Sheath thin-walled and contained a quantity of clear fluid. Tendons normal. Procedure—division of dorsal ligament.

Case 5.—A. G. A man, age 55. Duration of symptoms—one month. Causative factor—machine work. Typical signs. X-ray negative. Operation June 19, 1941. Pathology—diffuse thickening of dorsal ligament. Moderate amount of clear fluid in thickened sheath. Procedure—division of dorsal ligament.

Case 6.—G. A. A woman, age 50. Duration of symptoms—two months. Causative factor—housework. Typical signs with noticeable swelling over sheath. X-ray negative. Operation June 24, 1942. Pathology—diffuse thickening of dorsal ligament. Procedure—division of dorsal ligament. This patient is recovering slowly owing to an associated arthritis.

Case 7.—A. H. A woman, age 35. Duration of symptoms—seven months. Causative factor—stenography. Typical signs with noticeable swelling. X-ray negative. Operation July 31, 1942. Pathology—diffuse thickening of dorsal ligament with increased fluid within sheath. Procedure—division of dorsal ligament with excision of edges.

Case 8.—A. M. A nurse, age 30. Duration of symptoms—one week. Sudden pain developed in the process of drawing a sheet tightly across a bed. Typical signs. X-ray negative. The hand, wrist and forearm were immobilized for one month without benefit. Operation October 8, 1942. Pathology—moderate thickening of the dorsal ligament, thickening of sheath with excess fluid. Procedure—division of dorsal ligament.

CONCLUSIONS

DeQuervain's disease, or stenosing tendovaginitis at the radial styloid, is a relatively common but frequently overlooked condition. The symptomatology is definite. The surgical treatment is simple and uniformly successful. It is hoped by once again describing the outstanding characteristics of this disease that it will be more frequently recognized.

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TRENDS IN GENERAL SURGERY

REVIEW OF FIVE YEARS SURGICAL EXPERIENCE AT HARPER HOSPITAL

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HARPER HOSPITAL is a 600-bed general hospital of which approximately 250 beds are devoted to general surgery. There are 110 general surgeons on the hospital staff. Twelve surgeons perform two-thirds of all the major general surgery. This is preponderately a private institution as only ten beds are set aside for Staff general surgery, done by the resident surgeon under the supervision of an attending surgeon. Five beds are similarly assigned to Staff gynecology.

The present communication is a review of the total surgical statistics for the five-year period from 1937 to 1941. The aim is to present the average situation in a general hospital of this type, as indicating the risks in operations, and a few of the trends in general surgical practice. No attempt is made to present an exhaustive discussion of each group of surgical procedures.

A comparison of the total surgical admissions, the total major operations, and the operative mortality rates for the five-year period, is shown in Table I.

TABLE I

TOTAL OPERATIONS AND MORTALITY RATES

	1937	1938	1939	1940	1941
Surgical admissions	10,014	9,016	8,754	8,407	11,125
Major operations*	3,755	3,600	3,509	3,891	4,233
Operative deaths	178	98	110	108	128
Per cent operative mortality rate†	4.8%	2.7%	2.3%	2.8%	3.0%
Nonoperative deaths‡	93	82	59	66	68

*Major operations include the following surgical procedures: All abdominal operations, thyroidectomy, mastectomy (simple and radical), thoracic surgery, nephrectomy, herniorraphy, extensive perineal repair, prostatectomy (suprapubic and transuretheral), repair of wound disruption, major orthopedic operations, amputation of extremities, mastoidectomy, Caldwell-Luc operations, radical frontal operations, and neurologic surgery.

The hospital practice is to list the following operations as *minor procedures:* Surgery of the eye, adenoidectomy, tonsilectomy, submucus resection, bronchoscopy, tracheotomy, biopsy, simple perineal repair, incision of abscess, diagnostic curettage, hemorrhoidectomy, polypectomy, fistulectomy, hydrocelectomy, epididymectomy, orchidectomy, dental surgery, suturing of tendons and lacerations, and closed reductions of fractures. These cases have not been included in the statistical data.

†During this five-year period the mortality rate for all major surgery has averaged approximately 3.2 per cent.

‡Nonoperative deaths include all deaths occurring on the Surgical Service upon whom no operation was performed. Of the 68 nonoperative deaths during 1941, two-thirds were due to carcinoma of various organs, brain tumors, sarcomata, Hodgkin's disease, and cirrhosis of the liver. The remainder of the deaths were the result of burns, uremia, cerebral apoplexy, ruptured kidney, leptomeningitis, skull fractures, fractures of femur, influenza, pneumonia, hemorrhage from intestinal tract, *etc.*

The autopsy rate for 1941 is low (Table II). There is a very concerted effort being made to raise the percentage rate for 1942. In a private hospital, the intern staff must receive the wholehearted support of the attending physicians to obtain permission for postmortem examinations.

TABLE II

AUTOPSY STATISTICS, 1941

	No. of Cases	Per Cent of Total Deaths
Total autopsies for 1941	170	34.5%
Surgical autopsies	83	42.0%
Medical autopsies	87	30.0%

SURGERY OF THE APPENDIX

During 1941 there were 1502 appendicectomies performed at Harper Hospital, *i.e.*, 35.5% of all major operations. This disease stands out as the most common condition for which surgical intervention is undertaken.

In Graph I we have attempted to show certain trends in the surgical aspects of appendicitis during the past five years. The following conclusions can be drawn:

(1) There has been an increase in the total number of appendicectomies performed during this period.

(2) The total mortality rate for appendicitis and its complications treated surgically has fallen to the low mortality rate of 0.3% in 1941, or five deaths in 1502 operations.

(3) In 1941 there were 41 operations for acute appendicitis, with either abscess or generalized peritonitis. There were no deaths among these patients. This indicates a very significant advance in the treatment of this disease.

(4) The number of cases of appendicitis, with peritonitis, submitted to surgery has increased while the number of patients with abscess formation has decreased. There is apparently a definite tendency toward earlier operation in ruptured appendicitis without waiting for a localization of the infection and abscess formation.

A more detailed analysis of the appendicectomies performed in 1941 is illustrated in Table III.

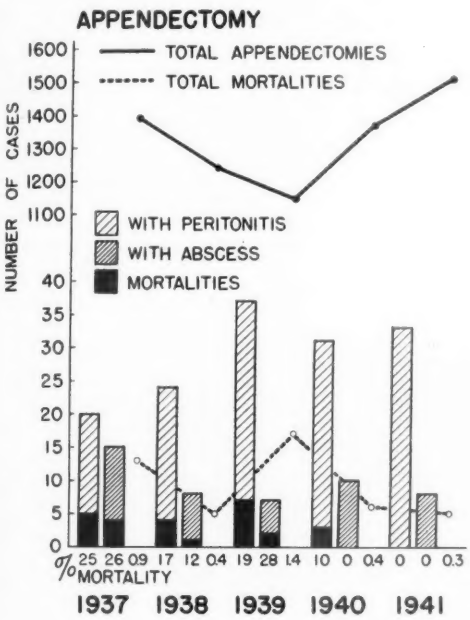
Analysis of the five deaths following appendicectomy during 1941 are listed as follows:

TABLE III

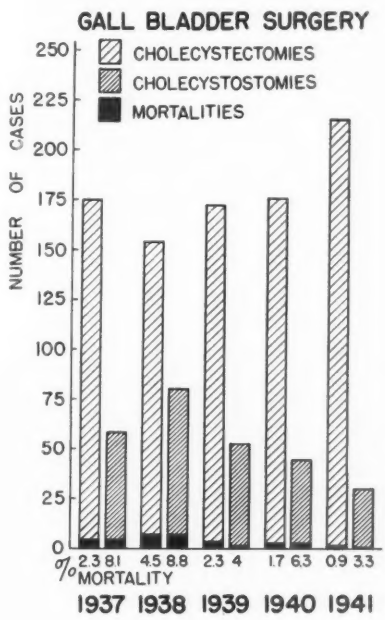
CLASSIFICATION OF APPENDICECTOMIES, 1941

	No. of Cases	Deaths
Acute uncomplicated appendicitis	240	0
Subacute appendicitis	40	0
Interval and chronic appendicitis	701	2
Acute appendicitis, with abscess	8	0
Acute appendicitis, with peritonitis	33	0
Carcinoid of appendix	1	0
Appendicectomy in conjunction with other operative procedures	479	3
	1502	5....0.3%

a. Two deaths listed as chronic appendicitis: (1) An appendicectomy was performed on a 19-year-old white female, who was five months pregnant. She died 36 hours postoperatively from an acute massive bilateral pneumonia and pulmonary edema secondary to a weakened heart. No autopsy was obtained. *Pathologic Report:* Chronic catarrhal appendicitis. (2) A 52-year-old Polish male, who could speak no English, was admitted to Harper Hospital with generalized abdominal cramps, diarrhea, and nausea of nine days duration. An appendicectomy was performed in conjunction with severing of peritoneal bands at the terminal ileum. The patient died on the fifth postoperative day. Autopsy revealed an acute toxic hepatitis, cerebral congestion, and hemorrhage into the great mesentary. *Pathologic Report:* Chronic catarrhal appendicitis.



GRAPH I



GRAPH II

b. Three deaths listed "Appendicectomy with other operations": (1) Cholecystectomy and appendicectomy were performed on a 36-year-old white female. She died 48 hours postoperatively of an extensive bilateral pneumonia, suggestive of an aspiration type and an old rheumatic heart disease. No autopsy was obtained. *Pathologic Report:* Chronic catarrhal appendicitis. (2) An appendicectomy was performed on a 71-year-old white male, in conjunction with a repair of a strangulated right inguinal hernia. The patient died on the twenty-ninth postoperative day of a probable pulmonary infarction, and arteriosclerotic heart disease. No autopsy was obtained. *Pathologic Report:* Chronic catarrhal appendicitis. (3) A transuretheral prostatectomy was performed upon a 58-year-old white male. Three weeks later he developed acute abdominal symptoms, diagnosed as acute appendicitis.

Appendicectomy was performed, and the patient died 13 days postoperatively. Autopsy diagnosis was pulmonary edema and acute tubular nephrosis. *Pathologic Report:* Chronic catarrhal appendicitis.

In summarizing the causes of death in the above five patients none were due to intra-abdominal complications: The causes of death are listed below:

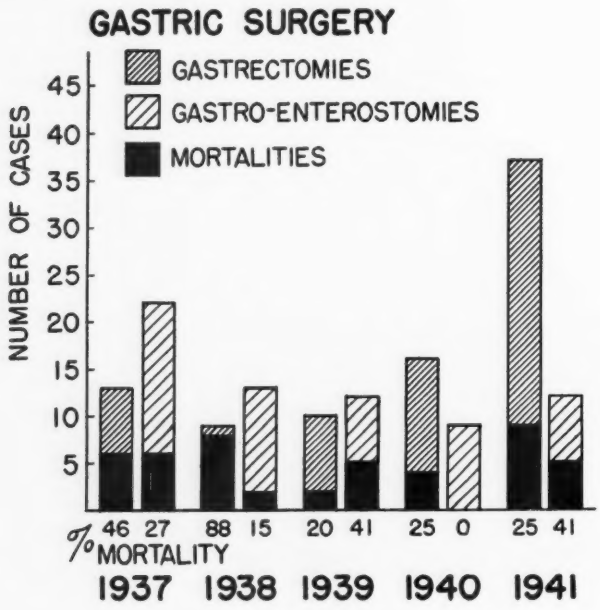
(1) Massive pneumonia during pregnancy.

(2) Toxic hepatitis.

(3) Aspiration pneumonia (associated cholecystectomy).

(4) Pulmonary infarction (associated strangulated hernia).

(5) Pulmonary edema and acute tubular nephrosis (associated prostatectomy).



GRAPH III

SURGERY OF BILIARY TRACT

It is generally recognized that safe and successful surgery of diseases of the biliary tract requires mature judgment and much experience. In Graph II are depicted the trends and results of biliary surgery:

(1) There has been a decided increase in the number of cholecystectomies performed during the past few years. In 1941, 217 cholecystectomies were performed, with two deaths (0.9% mortality). One hundred ninety-three of these cases were for chronic cholecystitis.

(2) Cholecystostomy has had a steady decline in employment during the past five years. Thirty cholecystostomies were performed during 1941, with one death (3.3% mortality). Nineteen of these were for chronic and 11 for acute cholecystitis.

Data on the incidence of exploration of the common duct, drainage of

the common duct, and the incidence of jaundice were not obtained, but these complications are included in the above statistics.

SURGERY OF THE STOMACH AND SMALL INTESTINES

Though the number of gastrectomies is not large, there was a marked increase in 1941 (Graph III). Approximately two-thirds of these operations were for peptic ulcer and one-third for carcinoma of the stomach. The mortality rate for gastrectomy during the past three years has ranged from 20 to 25 per cent. The mortality rate for gastrectomy in the presence of peptic ulcer was 19 per cent for 1941, approximately the same as for carcinoma of the stomach. However, one surgeon performed 13 gastrectomies during 1941, with a mortality of 7.7 per cent. One of the authors (M.J.T.) performed ten gastrectomies in 1942 with no deaths.

There have been almost the same number of gastro-enterostomies performed each year, *i.e.*, 10 to 15 cases. Of the 11 gastro-enterostomies performed in 1941, five were for carcinoma and six for obstructing duodenal and pyloric peptic ulcers. The mortality (1941) was 41%. Death following gastro-enterostomy was caused by atelectasis, bronchopneumonia, difficulty with the stoma, ascites, and extension of the carcinoma of the stomach.

Gastrostomy is an uncommon operative procedure in Harper Hospital, there being only three such operations during 1941. Enterostomy has not been entirely replaced by the use of the Miller-Abbott tube. Eleven enterostomies were performed in 1941, with two deaths, an operative mortality rate of 18%.

The mortality from perforated peptic ulcer is difficult to analyze. However, one can say that the mortality rate for operative treatment of this complication of peptic ulcer during the past 11 years in Harper Hospital is over 20 per cent, and has shown no improvement during the past five years (Table IV).

TABLE IV

PERFORATED PEPTIC ULCERS

Year	Total No. of Cases	Nonoperative		Operative		
		Cases	Deaths	Cases	Deaths	% Mortality
1937	21	2	1	19	5	26.0%
1938	21	2	0	19	2	10.5%
1939	11	1	1	10	2	20.0%
1940	9	1	1	8	4	50.0%
1941	22	1	1	19	3	15.8%

Analysis of deaths from perforated peptic ulcer during 1938 to 1941 revealed:

(1) Three patients died without benefit of surgical intervention. Two of these had symptoms of perforation from 24 to 48 hours before admission, and both died within one day after admission to hospital. The third patient had been ill for three weeks with severe pain and increasing jaudice. Autopsy revealed an unsuspected perforated peptic ulcer of the duodenum involving

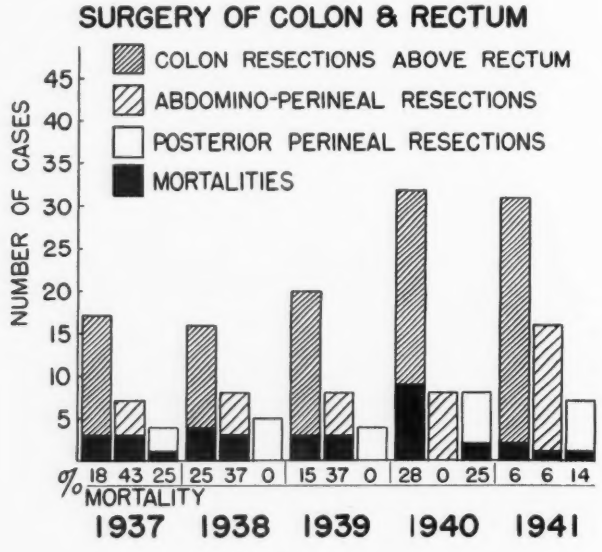
the liver and common duct. All of these patients entered the hospital in a moribund condition and failed to respond to preoperative treatment.

(2) Of 11 patients who died following operation, the duration of symptoms of perforation in six cases was less than eight hours. Four patients died of pulmonary complications, and two from extension of the peritonitis. The operations were uniformly performed under spinal anesthesia, and consisted of closure of the perforation with interrupted sutures and reinforcing with omental fat. One fatal case had had a previous operation for closure of perforated peptic ulcer four years before.

In summary it is noted that an occasional patient with perforated peptic ulcer recovers without operation; several still come in in moribund condition, too ill to undergo operation. Of the postoperative deaths, several came in within six to eight hours of the time of perforation.

SURGERY OF THE COLON AND RECTUM

The number of operations performed upon the colon and rectum shows a decided increase. Surgery of the large intestine may be divided into three groups, on an anatomic basis (Graph IV):



Graph IV

(1) There were 31 resections of the colon above the rectosigmoid, for cancer and gunshot wounds, with a mortality rate of 6.5%, during 1941. Most of the operations were performed by the modified Mikulicz technic.

(2) Abdomino-perineal resections of the rectum for adenocarcinoma increased from six operations, in 1940, to 16, in 1941. The mortality rate has fallen sharply during the last year; in 1941, 16 abdomino-perineal resections were performed, with one fatality, a 6% mortality.

(3) Seven perineal resections for selected cases of adenocarcinoma of

the lower portion of the rectum were performed in 1941, with a 14% mortality rate.

HYSTERECTOMY

From the five-year statistics concerning surgery of the uterus, (Graph V), the following conclusions can be drawn:

(1) There has been a 50 per cent increase in the number of hysterectomies performed during the past four years.

(2) From 1937 to 1941, the mortality rate ranged between one and two per cent. In 1941, it dropped to 0.6% (three deaths) in 496 cases. Siddal and Mack[1] reported the experience of Harper Hospital in hysterectomies for the five years, 1928 to 1932. For that period the mortality was 3.3%.

(3) Of the hysterectomies performed, approximately one-half are performed by general surgeons and the other half by gynecologists.

(4) Hysterectomies performed by general surgeons show a higher mortality, the five year rate being 2.16%, as against 0.83% for the gynecologists.

The various types of hysterectomies performed during 1941 are shown in Table V. Vaginal hysterectomy is performed chiefly by the gynecologists.

TABLE V

TYPES OF HYSTERECTOMIES, 1941

	General Surgery		Gynecology	
	Cases	Deaths	Cases	Deaths
Supravaginal hysterectomy	183	2	159	1
Total hysterectomy	73	0	66	0
Vaginal hysterectomy	2	0	13	0
	258	2	238	1

Siddal and Mack,[1] in their study, found the mortality rate for total hysterectomy to be twice as great as for supravaginal hysterectomy in the 1928–1932 period. However, in 1941 there were no deaths from total hysterectomy, and this operation was performed in 25 per cent of the cases. Records do not show whether total hysterectomy was employed oftener in the less complicated cases.

WOUND DISRUPTION

Each year there are a few complete abdominal wound eviscerations—(40 in the entire five-year period). Only cases taken to the operating room for resuture are included. The mortality rate for the five-year period has averaged 32 per cent (Table VI).

TABLE VI

WOUND DISRUPTIONS

	1937	1938	1939	1940	1941
Total cases	13	8	5	8	6
Fatal cases	5	2	1	3	2
Per cent mortality rate	31%	25%	20%	37%	33%

Hysterectomy accounts for 25 per cent of the wound disruptions; and cholecystectomy and appendicectomy 17 per cent each.

HERNIA

Types of herniotomies and deaths for each of the five years, 1937 to 1942, are listed in Table VIII. The highest mortality rate during this period was 1.3%, in 1937, and dropped to 0.4%, in 1941. There is an occasional death in each classification but the most regular death rate occurs in the small group of strangulated herniae.

SURGERY OF THYROID

Subtotal thyroidectomy is the most common type of operative procedure employed in the treatment of goiter. Only 33 multiple-stage operations were listed during the past five years.

TABLE VII

OPERATIONS FOLLOWED BY EVISCERATION

Hysterectomy	10
Cholecystectomy	7
Appendicectomy	7
Carcinoma of viscera	5
Perforated peptic ulcer	3
Splenectomy	2
Colostomy	1
Acute pancreatitis	1
Epigastric hernioplasty	1
Intestinal obstruction	1
Subhepatic abscess	1
Perforated typhoid ulcer	1
No. of Cases	40

The mortality rate of thyroidectomy has been low for several years, the lowest being in 1941, when it was 0.7%, or three deaths in 286 cases (Graph VI).

During the past five years there have been nine cases of carcinoma of the thyroid.

The type of anesthetic agent used during thyroidectomy varied a great deal. Many surgeons use local novocain anesthesia and others gas-ether, with or without intratracheal intubation.

TABLE VIII

CLASSIFICATION OF HERNIOPLASTY

Types	Cases in 1941	Deaths 1937	1938	1939	1940	1941
Uncomplicated inguinal hernioplasties	608	5	0	1	1	0
Strangulated inguinal hernioplasties	17	3	1	1	0	2
Femoral hernioplasties	26	0	0	2*	0	0
Umbilical hernioplasties	13	0	0	1	0	1
Ventral hernioplasties	45	1	0	1	1	0
	709	9	1	6	2	3

*The two deaths listed under femoral hernioplasty occurred in the presence of strangulation of the intestine.

MASTECTOMY

There were no deaths from mastectomy, either simple or radical, during the past five years.

A study of Graph VII reveals the following trends:

(1) The number of mastectomies is increasing. The increase is chiefly in the simple mastectomy, and indicates an increasing appreciation of the importance of removing benign lesions of the breast.

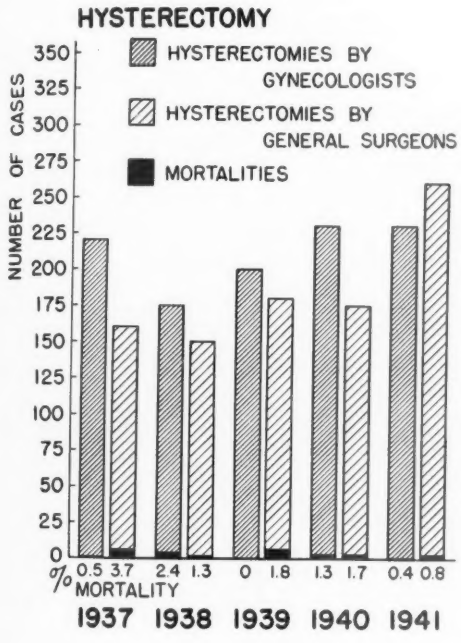
(2) The number of cases of carcinoma of the breast operated upon each year fluctuates, but is not increasing.

(3) Each year simple mastectomy is employed for less than ten cases of carcinoma. This is approximately 20 per cent of the total number of operations for cancer of the breast.

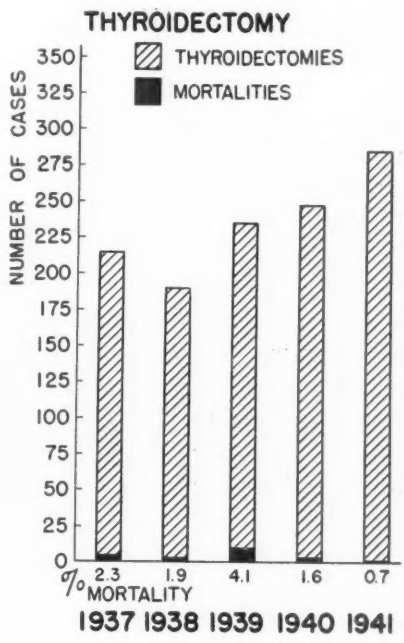
(4) Each year a few radical breast amputations are carried out for pathologic conditions other than carcinoma of the breast.

The percentage of patients who receive roentgenotherapy for carcinoma of the breast, while in the hospital, has noticeably decreased during the past two years. Approximately 45 per cent of the cases of carcinoma of the breast who leave the hospital without receiving roentgenotherapy return to the therapy department later.

Preoperative roentgenotherapy for carcinoma of the breast has become less popular during the past few years.



GRAPH V

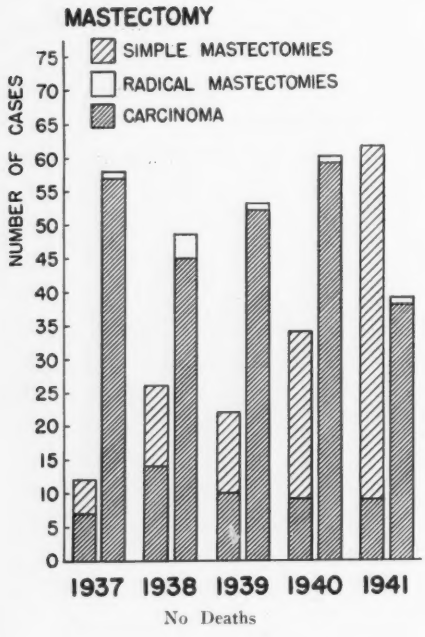


GRAPH VI

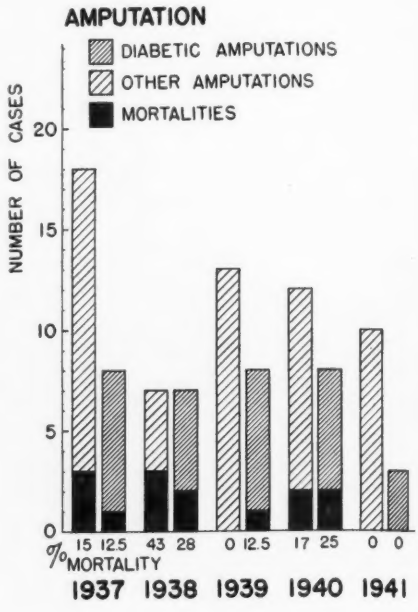
AMPUTATIONS

The total number of major amputations has always been small, and is decreasing. There were 26 amputations in 1937, and only 13 cases in 1941 (Graph VIII).

The mortality rate has been less in the presence of diabetes than for other diseases. The mortality rate for 13 major amputations during 1941



GRAPH VII



GRAPH VIII

was zero. Only three were in diabetic patients (a marked decrease from previous years). The diagnoses of the other ten amputations in 1941 were: Emboli, thrombosis, senile gangrene, osteomyelitis, traumatic injury, thromboangiitis obliterans, arteriosclerotic gangrene, osteogenic sarcoma, fibrosarcoma, and osteochondroma.

ANESTHETIC AGENTS AND PROCEDURES

A review of the types of anesthetic agents and procedures employed reveals that 55 per cent of the patients received gas-ether anesthesia. Approximately 25 per cent were operated upon under spinal anesthesia, either alone or supplemented with inhalation anesthesia. There is a noticeable trend away from the use of nitrous-oxide alone as an anesthetic agent.

TABLE IX

ANESTHESIA (AGENTS AND PROCEDURES) FOR MAJOR AND MINOR OPERATIONS

	1937	1938	1939	1940	1941	Per Cent of Total for 1941
Gas-ether	4290	3813	3807	4054	4000	55.2%
Spinal	1740	1556	1311	1576	1834	25.4%
Ether (alone)	275	271	313	324	394	5.4%
Nitrous oxide	461	392	279	116	131	1.8%
Cyclopropane	201	154	82	27	0	0.0%
Gas-evipal	1084	52	0	0	0	0.0%
Evipal (alone)	6	46	11	10	0	0.0%
Avertin	4	7	1	3	0	0.0%
Sodium pentothal (alone)	0	0	0	725	727	10.0%
Sodium pentothal plus ether	0	0	0	124	136	1.8%
					7222	

Intravenous sodium pentothal anesthesia, introduced to Harper Hospital in 1940, has become very popular, especially for short gynecologic operations, fractures, amputations, and operations of necessity in debilitated individuals. In this last group it is often combined with local novocain infiltration. Cyclopropane, ethelyene, avertin and evipal were not administered during 1941.

BLOOD TRANSFUSIONS

In May, 1939, a blood bank was established under the supervision of Dr. Warren H. Cooksey. The bank effected three important changes in transfusion technic:

(1) Direct blood transfusions have steadily decreased, and, since the advent of the blood bank, have been almost completely eliminated.

(2) The number of direct transfusions has been greatly increased. There has been more than a 500 per cent increase in the total number of transfusions during this five-year period.

(3) Plasma transfusions, introduced in 1939, are increasing in popularity.

TABLE X

BLOOD TRANSFUSIONS

	1937	1938	1939	1940	1941
Total transfusions in the hospital	247	925	1441	1659	1451
Transfusions to surgical patients:					
(1) Direct	61	28	11	3	1
(2) Indirect	186	611	966	1084	993
(3) Plasma	0	0	15	34	74

SUMMARY

A review of the major surgical procedures at Harper Hospital for the past five years (1937–1941) shows the following trends and risks:

(1) The average mortality rate for major operations has ranged from two to three per cent during the past three years.

(2) The hospital autopsy rate is 35 per cent of the total deaths.

(3) Appendicectomy is the most common major operation, and represents one-third of all major surgical procedures. In 1941, the mortality rate was 0.3%. No deaths occurred from intra-abdominal complications. There were no deaths in 41 patients who had either generalized peritonitis or abscess.

(4) The mortality rate for 217 cholecystectomies during 1941 was 0.9%. Cholecystostomy is less frequent than previously; there were 30 such operations performed in 1941, with a 3.3% mortality rate.

(5) Gastrectomy is increasing but the mortality rate is still quite high, *i.e.*, 20 to 25%. The mortality rate for perforated peptic ulcer treated surgically is approximately 22%.

(6) The total number of radical resections of the colon and rectum has increased during the past few years. The operative mortality rate is 6%.

(7) The number of hysterectomies is increasing. The mortality rate for this operation was 0.7% in 1941. There were no deaths from total

hysterectomy in 1941, and 40% of all hysterectomies were total.

(8) Each year there are six or eight major abdominal wound disruptions, with a mortality rate of 30%.

(9) During 1941, 700 hernioplasties were performed. There were three deaths (mortality 0.47%) of which two were in cases of strangulated herniae.

(10) The mortality rate for thyroidectomy was 0.7% during 1941.

(11) There were no surgical deaths from radical mastectomy during this five-year period. The number of carcinomata of the breast treated surgically varies, but is not increasing. Simple mastectomy for benign lesions has increased.

(12) Major amputations are decreasing, especially in diabetic patients. There were no deaths in 13 major amputations performed in 1941.

(13) Intravenous sodium pentothal anesthesia, introduced to Harper Hospital in 1940, has become very popular. Cyclopropane, ethelyene, avertin and evipal were not used during 1941.

(14) The introduction of the blood bank has resulted in (1) almost complete elimination of direct blood transfusions; (2) great increase in the indirect transfusion technic; and (3) an increasing administration of plasma transfusions.

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BRIEF COMMUNICATIONS

INTRACRANIAL CALCIFICATION

REPORT OF AN EXCEPTIONALLY LARGE CALCIFIED TUMOR

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CALCIFICATION which is roentgenologically demonstrable occurs in many types of intracranial lesions and in some of them it occurs with great frequency, e.g., suprasellar cysts, 41 per cent,[1] oligodendrogliomas, 31 per cent,[2] or more.[3]

However, such calcification is usually demonstrable as small plaques or areas of flocculent-like increased density, and it is very rare to see a huge solid shadow such as that observed in the following case:

FIG. 1.—Lateral roentgenogram of the skull, showing the huge area of calcification in the frontal region.

Case Report.—V. U. Hosp., No. 108016: Referred by Dr. O. H. Clements, of Palmer, Tenn. D. F. C., white, male, age 40, was admitted June 25, 1940, with a history of having had generalized convulsive seizures for seven years. For four years his family had observed progressive mental disturbances. He became inattentive, grasped situations poorly, showed poor judgment, and had increasing difficulty in speaking correctly. He used words incorrectly and often repeated words or phrases without seeming to realize it.

During the year before admission, his vision had failed progressively to the point of almost complete blindness. For six months, he had vomited occasionally, but he had had headaches for only ten days. His family was aware of no localized weakness

or paresthesia. There was no history of injury or of relevant family disorders. He was right-handed.

On examination, he was well oriented, but memory was poor and cerebration slowed. There was no definite defect of speech. There was blindness in the left eye and only light perception in the right. The optic disks were choked. There was a central type of facial weakness on the right. No other disturbance of neurologic function was observed. There were no significant laboratory abnormalities.

Roentgenograms of the skull showed a huge, almost uniformly dense shadow, measuring 7 x 7 cm., in the left frontal region (Fig. 1). Its outline was jagged and irregular.

FIG. 2.—Photograph of the tumor.

Operation.—July 8, 1940: Dr. Cobb Pilcher. A considerable amount of soft, dark tumor tissue lay on the external surface of the calcified mass in the left frontal lobe, but, when the latter was gently enucleated, its bed was smooth and there was no sign of neoplastic tissue in its depths. The tumor was removed *en masse* (though no doubt there was infiltration in the cortical layers), and weighed 97 Gm. (Fig. 2).

The postoperative course was smooth for 48 hours, when the patient suddenly developed the unmistakable signs of postoperative hemorrhage. The wound was reopened and a large hematoma evacuated from the tumor bed, but the patient survived the procedure only ten hours.

Histologic study showed the tumor to be an oligodendroglioma* (Fig. 3).

COMMENT

In 1916, Heuer and Dandy[4] reported two cases in which there was extensive calcification in intracranial tumors. In one unoperated case, the shadow was irregular in outline and in density, and measured 4 x 5 centi-

* In the actively growing portion of the lesion the neoplastic cells were primitive, many mitoses were present and the tissue was quite vascular. Dr. Louise Eisenhardt of New Haven, who kindly examined sections of the tumor, classifies it as an oligodendroblastoma.

meters in its greatest dimensions. In the other, a shadow, 5 x 6 centimeters, was attached to the skull (which also showed an external palpable protrusion).† This shadow, too, was irregular and appeared somewhat flocculent in some areas.

O'Sullivan,[5] in 1925, reported several fairly large intracranial calcifications, and Grantham and Smolik,[6] have recently described a large area of

FIG. 3A

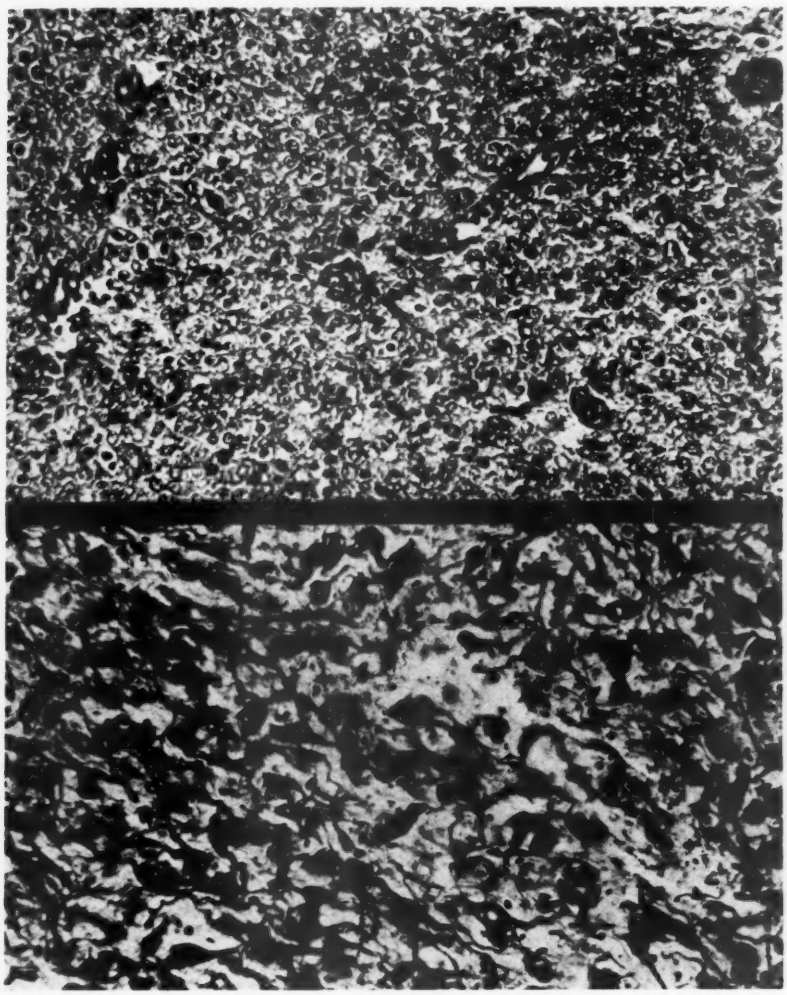

FIG. 3B

FIG. 3.—Photomicrographs of tumor. A. Note the poor staining qualities of the cytoplasm, giving the appearance of "halos" around the nuclei. Aniline blue-orange-G stain (reduced from a magnification of 250). B. The heavy protoplasmic processes of the tumor cells are uniformly impregnated. Penfield's silver method for oligodendroglia (reduced from a magnification of 250).

† This lesion was diagnosed osteosarcoma, but the author's description strongly suggests that it was a meningeal fibroblastoma.

calcification in an old intracerebral hematoma. Smaller calcifications of various types have been reported by many authors.

It is believed, however, that the tumor reported herein contained the largest area of calcification yet reported.

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A NEW AUTOMATIC TWO-WAY VALVE

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IN FEBRUARY, 1935, the author[1] described a simple automatic two-way valve to facilitate transfusions[2] and other therapeutic procedures, such as infusions, aspirations, phlebotomy, irrigations, *etc.* Since that time the unit has found considerable acceptance because of its proven value. In December, 1936, its successful use was recorded[3] in over 125 citrate transfusions on the Pediatric Service of the Mount Sinai Hospital.

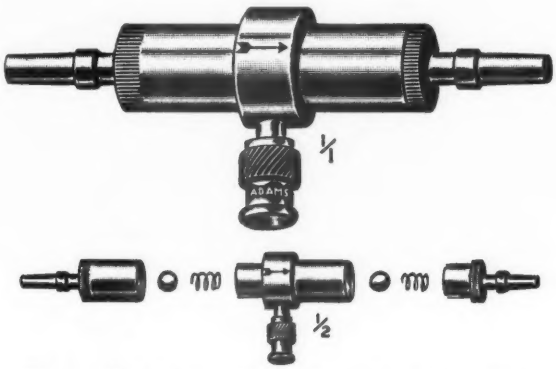

FIG. 1.—Unit taken apart showing ball valves, springs and direction of flow.

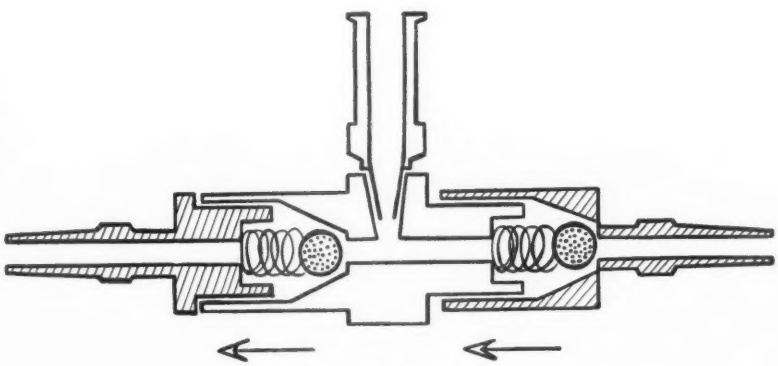

FIG. 2.—Diagrammatic view of unit.

Because of the war it has been very difficult to obtain the stainless steel from which the unit was made. To overcome this difficulty and to utilize more easily obtained and less essential metal, it has been found desirable to modify the unit somewhat. This modification permits the use of brass

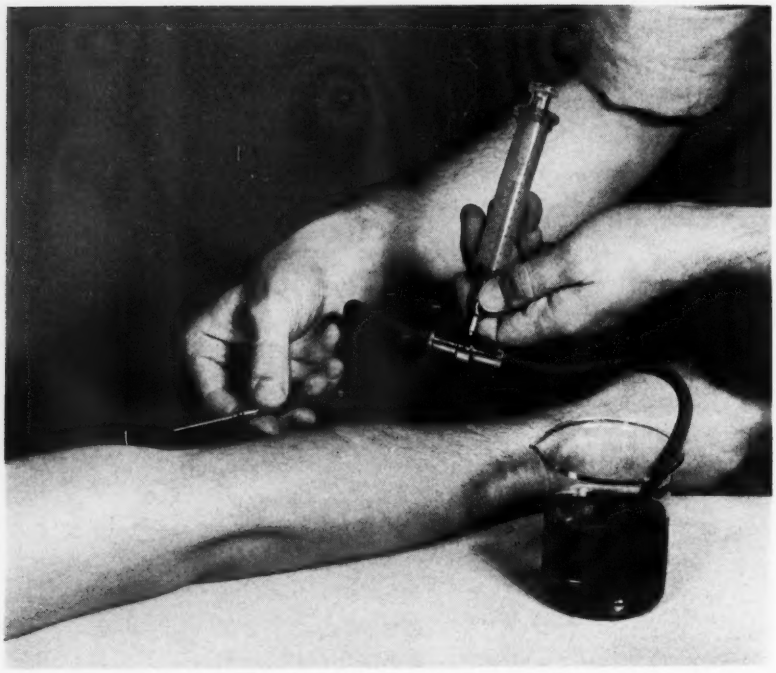

FIG. 3.—Complete set-up with citrated blood in beaker and needle in recipient's arm.

that is chromium plated and further permits the use of simple ball valves. Tiny springs, although not necessary, are included in the unit to insure perfect valve closures. Figure 1 illustrates the new apparatus. Its working principles are the same (Fig. 2). The upstroke of the syringe automatically opens the inlet valve and closes the outlet valve, and, conversely, the downstroke closes the inlet valve and opens the outlet valve. Both inlet and outlet fittings are so ground that either rubber tubing or needles may be attached directly to them. Its complete set-up for use is illustrated in Figure 3.

The fittings are removed by taking hold of the small, round, knurled nuts and pulling them out. The valves are easily removable, leakproof and airtight, so that there is no reflux. Any size Luer or record syringe with its adapter may be used with the apparatus.

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FIRST-STAGE THORACOPLASTY

COMPLETE EXCISION OF THE FIRST THREE RIBS THROUGH SHORT ANTERIOR AND POSTERIOR INCISIONS AT THE SAME OPERATION

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INCREASED EXPERIENCE with operative procedures for collapse therapy in pulmonary tuberculosis indicate that long paravertebral incisions, passing around the angle of the scapula, with division of large masses of muscle, and vigorous anterior displacement of the scapula, are unnecessarily traumatizing and occasionally productive of shock through tissue injury and loss of blood. As an alternative procedure, particularly in men, and occasionally in women who are not adverse to a small scar visible to themselves, the following operative plan is submitted for employment in suitable cases:

Operative Procedure.—Under cyclopropane anesthesia, the patient is placed on the operating table lying on the unaffected side, and is so draped as to provide access to both the anterior and the posterior chest wall. This is made possible by covering the hand and arm with sterile stockinette, thereby including the whole arm and shoulder in the sterile field. Following complete draping, the patient is turned almost flat on his back for the performance of the first half of the operation. A short incision (Fig. 1a) is made parallel and three centimeters lateral to the sternal border running downward from the clavicle for about ten centimeters, passing through the pectoralis major muscle at right angles to its fibers. The second rib is mobilized first, and about 12 centimeters, including the entire costal cartilage, removed. The first rib is then isolated and about six centimeters removed, together with most of its costal cartilage. The third rib is isolated last and about 10 to 12 centimeters removed, and if paradoxical respiration is not too pronounced, the costal cartilage is also removed. A more limited excision of the third rib anteriorly is indicated if paradoxical respiration is prominently present after resection of the first two ribs. As much of each rib as possible is freed of its periosteum lateralward, but only so much of the rib is removed as can easily be divided in the depth of the wound. Interrupted sutures of silk approximate the fascia of the pectoral muscle and the subcutaneous tissues, and a continuous suture of steel wire closes the skin. No drainage is provided.

Without changing drapes, the patient is rolled back on the unaffected side, the arm hanging forward in front of the chest. A short high incision (P in Figure 1) is made half-way between the spinous processes and the border of the scapula, passing through trapezius, rhomboid and serratus posterior muscles. The third rib is identified by palpation from above, and iso-

lated from transverse process to its free anterior end. The transverse process is also isolated, and removed together with the rib. Similarly, the posterior halves of the second and first ribs are isolated and removed together with their transverse processes.

To permit continuing and progressive compression as healing by fibrosis proceeds, regeneration of the excised ribs is inhibited over a short segment

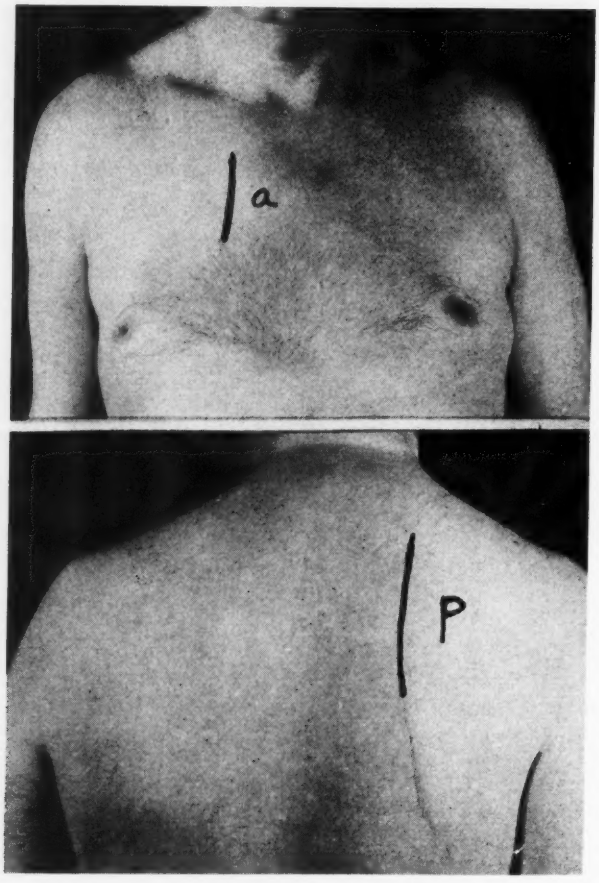

FIG. 1.—This patient was operated upon December 8, 1940, through two small anterior (a) and posterior (P) incisions for the complete removal of the first three ribs at the same operation. The posterior incision (P) was prolonged downward three weeks later for the removal of the posterior halves of the 4th, 5th, and 6th ribs, and partial removal of the lower third of the scapula, thus effecting closure of a large apical abscess.

by cauterizing, with the actual cautery or with the Bovey coagulating unit, the periosteum of the ribs for about three centimeters lateral to the site of the transverse process. The wound is closed by approximating the fascia of the trapezius muscle with interrupted silk sutures, and the skin is closed with continuous steel wire. No drainage is provided.

Postoperative care emphasizes a change of position through 90 degrees every hour during the first 36 to 48 hours, accompanied by six to eight

flexion and extension exercises of arms and legs with each change of position. At about half-hourly intervals, when awake, the patient is asked to breath deeply six or eight times. In the presence of bronchial exudate this usually initiates coughing and the bringing up of accumulated mucus. These precautions are most important: First, in preventing atelectasis secondary to the accumulation of mucus and exudate in dependent bronchi; secondly, in preventing abdominal distension by the avoidance of "water traps" in the intestines; and thirdly, in maintaining an active peripheral circulation to prevent femoral and peripheral venous thromboses and pulmonary emboli. These measures are considered vital in the postoperative care of all patients, but particularly after thoracic and abdominal operations. After the first two days, the patient is encouraged to change his position frequently, *unassisted*, using his own muscles rather than those of the attendant or nurse. Three hundred cubic centimeters of salt solution is instilled into the rectum every four hours for six doses, the first two instillations containing 60 grains of sodium bromide. Pain is controlled by pantopon, gr. ⅙, injected hypodermically every three hours, if necessary.

Postoperative rises in temperature and pulse are usually minimal. A very gratifying feature is a very pronounced lessening in postoperative pain, and, consequently, a much greater willingness to execute the changes of position and perform the exercises which are considered so vital in effecting an uncomplicated convalescence.

The second stage of the thoracoplasty is undertaken about two and one-half to three weeks later, when three or four ribs are partially resected posteriorly through a short incision overlapping the lower third of the previous incision and extending downward from it for about 10 to 12 centimeters.

At the second operation for high apical abscesses, only portions of the fourth, fifth, and sixth ribs are removed, but under these conditions the lower third of the scapula is also excised to permit the remaining scapula to fall into the rib defect, thus producing compression where it is most needed, and conserving as much healthy lung as possible. When seven or eight ribs are removed, partial excision of the scapula is not necessary, as the whole scapula then falls naturally into the rib defect.

It should be emphasized that thoracoplasties through short incisions are possible, with confidence, only after having familiarized oneself thoroughly with the problem of rib resection through the longer and more revealing paravertebral incision. Part of each of the above procedures is necessarily accomplished through the sense of touch, rather than through the sense of sight.

SUMMARY

The first-stage upper thoracoplasty for pulmonary compression is effected with lessened shock and with lessened loss of blood when performed through

two small incisions, instead of through the conventional long paravertebral incision. The first incision is made anteriorly, paralleling the sternal border, through which the medial halves of the first three ribs together with their costal cartilages may be removed; the second incision is made posteriorly, paralleling the vertebral border of the scapula in its upper half through which the remainder of the first three ribs together with their transverse processes are removed, both incisions being made at the same operation. The second-stage thoracoplasty may be performed two and one-half to three weeks later through a second short posterior incision.

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BOOK REVIEWS

Synopsis of Traumatic Injuries of the Face and Jaws. By Douglas B. Parker, M.D., D.D.S. C. V. Mosby Co., St. Louis, 1942.

In this little handbook of surgery, with 229 illustrations, the author has given us a very handy working manual that ought to be in the "haversack" of every dental and medical officer in the armed forces. The text is put together in a very logical and readable manner, and is up-to-the-minute in every detail in the treatment of traumatic injuries of the face and jaws.

In this global war, where front lines are created overnight, and where wild islands and barrens coasts are invaded, very few maxillofacial centers will be established anywhere near the front, where the dental surgeon and the surgeon can carry out very advance treatment in the case of the injuries of the face and jaws. This is a war of movement and the medical and dental officers will have to supplement each other and in many instances do each other's work, which will often be "first-aid" in character. This guide book will help the medical officer in bringing together the hard and soft tissues of the face and jaws into approximation and will give the dental officer quite a lot of information in arresting hemorrhage, shock, infection, methods of resuscitation, and the reduction and fixation of fractures of the bones of the jaws and face.

There is practically no dentistry at the front, and, more than ever, the dental officer is called upon to give first-aid treatment either in the Army or Navy. This book will answer many questions quickly for the medical and dental officer at the front who is up against something that he has never seen before and needs help in a hurry.

The chapter on anatomy is clear and explicit and quite adequate for a book of this size. The author deals in a very practical manner with the "early treatment of the injury at the scene of the accident," and his remarks should tend to eliminate a lot of confusion, and help the patient get what he most needs in a hurry, namely, intelligent and skillful first-aid treatment. The early treatment of these face and jaw injuries, not only will give us better postoperative results, but in some cases will save lives.

The later treatment of wounds and burns of the face presented, is up-to-date, scientific and sound in every way. His treatment of bony injuries and the stabilization of fractures is most excellent and should be of great help to the medical officer who has had very little experience, as a rule, in the care of fractures of the bones of the face and jaws. The description of intermaxillary wiring and the different types of intra- and extra-oral splinting is most thorough and adequate.

Local anesthesia is also well cared for and, again, this ought to be a great help to the medical officer who is not so familiar with producing anesthesia of the face and jaws. Dr. Parker has been very successful in getting together excellent illustrations that go hand-in-hand with a clear, concise text, which makes this little guide a great help to the practitioner and will undoubtedly assist him in obtaining better end-results in this field of surgery.

The book being published at this time ought to help indirectly many of our boys now at the front who will need the best of care for wounds of the face and jaws.

Henry Sage Dunning, M.D., D.D.S.

Sulphanilamide and Related Compounds in General Practice. Second Edition pp. 374. Wesley W. Spink, M.D., F.A.C.P. Associate Professor of Medicine, University of Minnesota Medical School. The Yearbook Publishers, Inc., Chicago, 1942.

The subject of this book is one of tremendous importance and of widespread interest. The material is presented simply and clearly so that it enables the reader to get a comprehensive view of sulfanilamide therapy. The arrangement of the book is logical and it is indexed adequately for ready reference. It is not profusely illustrated but a numbe

of clinical charts are reproduced showing typical responses to chemotherapy in various conditions.

Suggested dosages of sulfanilamide for severe infections may seem a little high to some physicians as they do to the reviewer. While most physicians would agree that a moderate degree of cyanosis is not a contraindication to the continued administration of sulfanilamide, the severe degrees of cyanosis are sometimes a prelude to more serious toxic manifestations.

The author is to be congratulated especially on the chapters on "Historical Development" and "Toxic Manifestations." The book is concluded with a very valuable fifty-five page bibliography so arranged that the original sources dealing with particular phases of the subject of chemotherapy may be easily found.

J. E. RHOADS, M.D.

TEXTBOOK ON FRACTURES. By Paul B. Magnuson, M.D. Fourth Edit., 1942. J. B. Lippincott Co., Philadelphia.

NO BETTER COMMENT can be made for this book than the fact that four editions have appeared in less than ten years, and the most recent one fully maintains the reputation that has been earned by the previous three.

It is more than timely in its appearance because its revision was not started until the certainty of our participation in World War II was established, making it possible for the author to anticipate the changes in treatment made necessary by the changing types of warfare.

The author has made an effort to express, in a concrete way, the accepted primary treatment and transportation of fractures as they occur in warfare, and, as he says, they represent the consensus of the Committee on Orthopedic Surgery of the National Research Council as constituted at the publication of this edition. Though the choice of methods in civil practice may be governed by circumstances and the judgment of the surgeon, in warfare; individualization to any great extent is not justifiable, and a more rigid standardization becomes necessary. However, such standardized treatments should be based upon a knowledge of the physiology and anatomy of the part involved, and a consideration of the fact that it is an injury to the body as a whole, and not just one part of it that requires the surgeon's care.

The text covers not only fractures of the long bones and joints, but includes the spine and hernia, in a way which should prove of great value to the military surgeon, who will rarely have had the advantage of a training in neurosurgery.

One is impressed by the lack of space devoted to open reduction of fractures of the long bones, and the use of fixation methods as employed by Boehler, Rodger Anderson and Stader, and it may be that sufficient time has not elapsed to properly evaluate these methods and determine their relative positions in the accepted methods of treatment of these injuries.

It would be difficult to find a more satisfactory piece of printer's work; the clear type, the paper, and the perfect illustrations not only attract but make the reading of the text more profitable than usual in a book of this size.

WALTER ESTELL LEE, M.D.

EDITORIAL ADDRESS

Original typed manuscripts and illustrations submitted to this Journal should be forwarded prepaid, at the author's risk, to the Chairman of the Editorial Board of the ANNALS OF SURGERY

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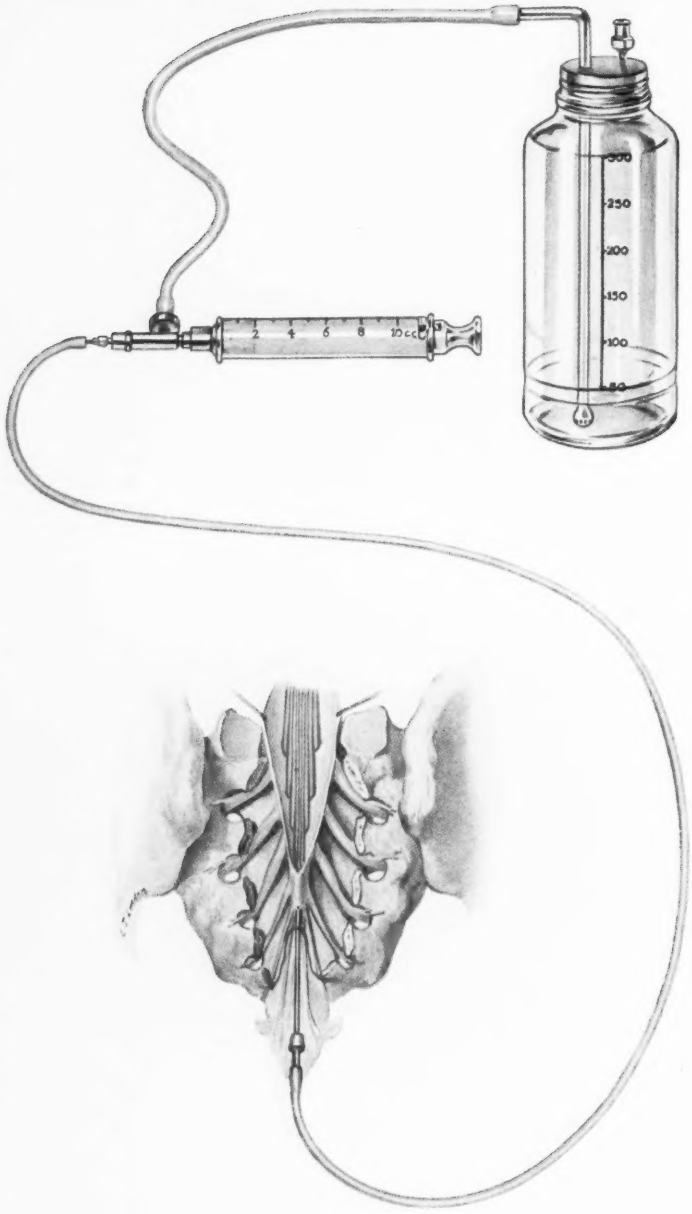

PLATE I.—Assembly of needle, tubing, syringe and container for the solution of the anesthetic agent.